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The terrestrial Mollusca of the Kruger National Park: a contribution to the malacology of the Eastern Transvaal†

by

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SYNOPSIS

A survey of the land molluscs of the Kruger National Park, E. Transvaal, has resulted in the discovery of five new species, *Pseudoglessula* (*Kempioconcha*) *hamiltoni*, *Streptostele* (*Raffraya*) *meridionalis* and *S.* (*R.*) *sanctuarii* (all figured) and two slugs of the family Aperidae, while *Conulinus metuloides*, *Afropunctum zanguebaricum*, *Guppya rumrutiensis* (fig.), *Subulina gracillima*, *S. mamillata*, *Gonaxis gwandaensis* and *Gulella perissodonta* are new to the South African list. A total of 50 species, of which six are slugs (data supplied by Dr. L. Forcart), are discussed. Anatomical data are supplied for *Pupoides calaharicus*, *Rachis jejuna*, *Conulinus mcbeanianus*, *Succinea africana*, *Trochonanina mozambicensis*, *Subulina gracillima*, *S. mamillata*, *Pseudoglessula hamiltoni*, *Opeas lineare*, *Achatina immaculata* and *Gonaxis gwandaensis* (all figured). The following synonymies have been established: *Conulinus mcbeanianus* var. *lemaneensis* = *C. mcbeanianus*, *Opeas lineare* var. *levis* = *O. lineare* and *Achatina panthera* = *A. immaculata* (type locality restricted to Lourenço Marques, Mozambique). Very many species are definitely cryptozoic in ecology and it seems that the dry climate, resultant poor vegetation and unsuitable subsoil all contribute to the poverty of the land snail fauna. The malacofauna of the Kruger National Park shows a mixture of tropical, transitional and temperate elements (60, 34 and 4% of the species respectively) and may be considered an impoverished offshoot of that of the Mozambique Plains, mainly on account of the low rainfall. The Transvaal Highveld and its fringes appear to be a centre of endemism, mainly of transitional elements allied to tropical species.

CONTENTS

Page
1. Introduction . . . 315
2. Acknowledgements . . . 318
3. Systematic list . . . 318
4. Notes on slugs . . . 390
5. Ecological notes . . . 390
6. Zoogeographical notes . . . 395
7. References . . . 398

1. INTRODUCTION

The Kruger National Park, South Africa's greatest game and nature sanctuary, occupies a long and narrow stretch of the Transvaal lowveld between the Levubu River in the north and the Crocodile River in the south, the eastern boundary being formed by the Lebombo Range (fig. 1). The western boundary is very irregular and highly artificial. The game reserve is thus situated between 22° 25′ to 25° 32′ latitude south and between 30° 50′ and 32° 2′ longitude east. It has a maximum length of approximately 210 miles and is nowhere wider than 55 miles; the Tropic of Capricorn cuts through somewhat north of the middle. The whole area contains about 7340 square miles of very varied country with an altitude of between 600 and 2750 feet above sea level (lowest and highest altitudes respectively), while most of the vast and undulating area lies between 600 and 1600 feet above sea level. Unfortunately this game reserve is anything but an ecological unit, a fact which on the other hand accounts for a greater diversity in fauna and vegetation.

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The rainfall varies from a minimum of about 15 inches per annum to a maximum of about 27 inches per annum; most parts of the area experience a poor rainfall, particularly the districts north of the Olifants River. Temperatures vary enormously, but on the whole summers may be described as hot (average daily maximum temperature 30°C. in January, average daily minimum temperature 18°C. in January, extremes 43°C. and 7°C. respectively) and wet (almost all precipitation falls between October and April), while winters are cool (average daily maximum temperature 23°C. in July, average daily minimum temperature 8°C. in July, extremes 35°C. and —2°C. respectively) and dry (hardly any precipitation between April and October).

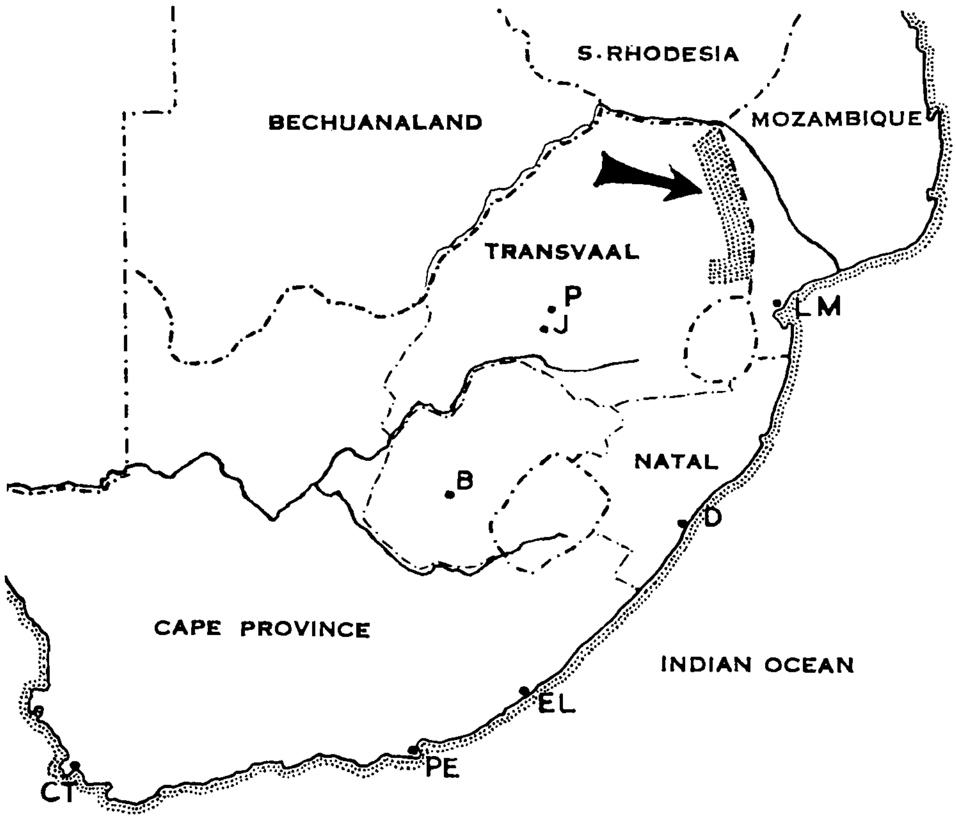

Fig. 1. Location of the Kruger National Park in South Africa. B = Bloemfontein, CT = Cape Town, D = Durban, EL = East London, J = Johannesburg, LM = Lourenço Marques, P = Pretoria, PE = Port Elizabeth.

As expected, the geology of the Kruger National Park is as diverse as the climate, vegetation and fauna. Concise information on these subjects is contained on the official tourist maps which incorporate small maps on rainfall, vegetation and geology. The vegetation of the game reserve is well-known and the student is referred to descriptions by Codd (1951), Van der Schijff (1957), Pienaar (1963a) and Brynard (1964); Van der Schijff recognises six main veld types, viz., (*a*) large-leafed deciduous woodland with tall grass, (*b*) mixed *Combretum* veld, (*c*) Knobthorn (*Acacia nigrescens*)-Marula (*Sclerocarya caffra*) parkland, (*d*) communities of dolerite dikes, (*e*) Mopani woodland, (*f*) sandveld communities of Punda Milia and Nwambiya. Pienaar (1963a) gives a very good general account of the natural features of the Kruger National Park.

The invertebrate fauna of the Kruger National Park is still very poorly known. The molluscs of this area (and indeed of the Eastern Transvaal as a whole) were hitherto particularly imperfectly known, the only references in the literature being those by Haas (1936), Connolly (1939) and Mandahl-Barth (1958); among these the terrestrial molluscs are conspicuous by their almost complete absence. The official list of the Kruger National Park land molluscs so far has consisted of seven species only, viz.,

Tropidophora transvaalensis (M. & P.),
Succinea africana Krss.,
Succinea exarata Krss.,
Succinea striata Krss.,
Trochonanina mozambicensis (Pfr.),
Opeas lineare (Krss.),
Achatina immaculata (Lam.).

Haas (*op. cit.*) has been the only one to attempt to give a list of the molluscs of the game reserve; he included five of the above-mentioned species of terrestrial molluscs and a fair number of fresh-water species. Connolly (*op. cit.*) and Mandahl-Barth (*op. cit.*) gave some casual references to material from this area, the latter only fresh-water species which are known bilharzia vectors.

The bulk of the collections available for the present study was assembled on two trips to the Kruger National Park, sponsored jointly by the National Parks Board and the Natal Museum. On the first trip (24.IV—7.V.1962) material was collected at 33 localities by the author, his wife, Ranger P. van der Hyde and an African assistant; on the second trip (19.II—2.III.1964) material was gathered at 70 localities by the author, his wife, Assistant-Biologist (K.N.P.) P. van Wyk and the same African assistant. On both trips collections were made throughout the Kruger National Park from south to north. The collecting expeditions were organised by the Biologist K.N.P. and his staff in such a way as to make these as profitable as possible, which indeed accounts for the outstanding results, particularly of the 1964 expedition. The presence of four experienced collectors at every locality to be investigated is probably unique in the history of malacology.

Furthermore material collected by the Biologist K.N.P. and his staff in the course of the years and specimens assembled by Dr. R. F. Lawrence on various collecting trips completed series obtained on the above-mentioned excursions. A few specimens obtained by the Swedish South Africa Expedition 1950-1951 have also been included. All this has resulted in a total of 632 samples being available for study. The bulk of the collection has been deposited in the Department of Malacology of the Natal Museum, while a representative set has been lodged at the Biologist's headquarters at Skukuza, Kruger National Park. Some historical specimens have been traced in the mollusc series of the Transvaal Museum (Pretoria) and South African Museum (Cape Town); this material has been referred to under *Trochonanina mozambicensis* and *Achatina immaculata.*

2. ACKNOWLEDGEMENTS

First and foremost acknowledgements are due to the Biologist K.N.P. Dr. Uys de Villiers Pienaar and his staff for arranging field trips, collecting material and attending to seemingly endless correspondence; Dr. Pienaar also kindly read the manuscript of the present paper. The National Parks Board of Trustees granted abundant facilities to undertake the work for which the author desires to express his appreciation.

Facilities for working on Southern African non-marine molluscs in the Natal Museum are indeed unmatched; however local scientists still have to rely on the co-operation of fellow-scientists overseas. Thanks are due to Dr. C. O. van Regteren Altena (Leiden, Netherlands), Dr. L. Forcart (Basle, Switzerland) and Dr. B. Verdcourt (England) for valuable help in various problems. Furthermore the author owes a debt of gratitude to the late Dr. K. H. Barnard, Mr. A. M. Brynard (Skukuza), Dr. R. F. Lawrence, Dr. J. C. Poynton, Dr. J. A. Pringle (all of Pietermaritzburg) and Mr. W. D. Haacke (Pretoria) for advice and assistance.

Finally the South African Council for Scientific and Industrial Research has favoured the author with a number of grants for running expenses, enabling Mrs. W. H. van Bruggen to undertake many technical duties which have greatly assisted in the current research. The author desires to express his gratitude to both the C.S.I.R. and his wife.

3. SYSTEMATIC LIST

In the following list the nomenclature and system of Zilch's manual (1959-1960) have been followed throughout with few exceptions (e.g., in the family Streptaxidae). Literature citations under every species have been limited to original descriptions, recent synonymy, papers by Connolly (1925, 1939) and Germain (1935) and subsequent records. Complete synonymy and other citations can be found in Connolly's three major publications (Connolly, 1912, 1925, 1939).

Kruger National Park records are enumerated in numerical sequence, starting with blocks in the southern area (S-blocks, area between Crocodile and Sabi Rivers), followed by those in the central (C-blocks, area between Sabi and Olifants Rivers) and northern areas (N-blocks, area between Olifants and Levubu Rivers). With few exceptions only material seen by the present author has been enumerated in the list of localities for every species. On the maps only the relevant blocks (see guide maps in Lawrence, 1964) have been shown; precise localities are not indicated, because it was found impossible to do so on the small maps available. New records from outside the Kruger National Park have been indicated by the words *new records* in italics.

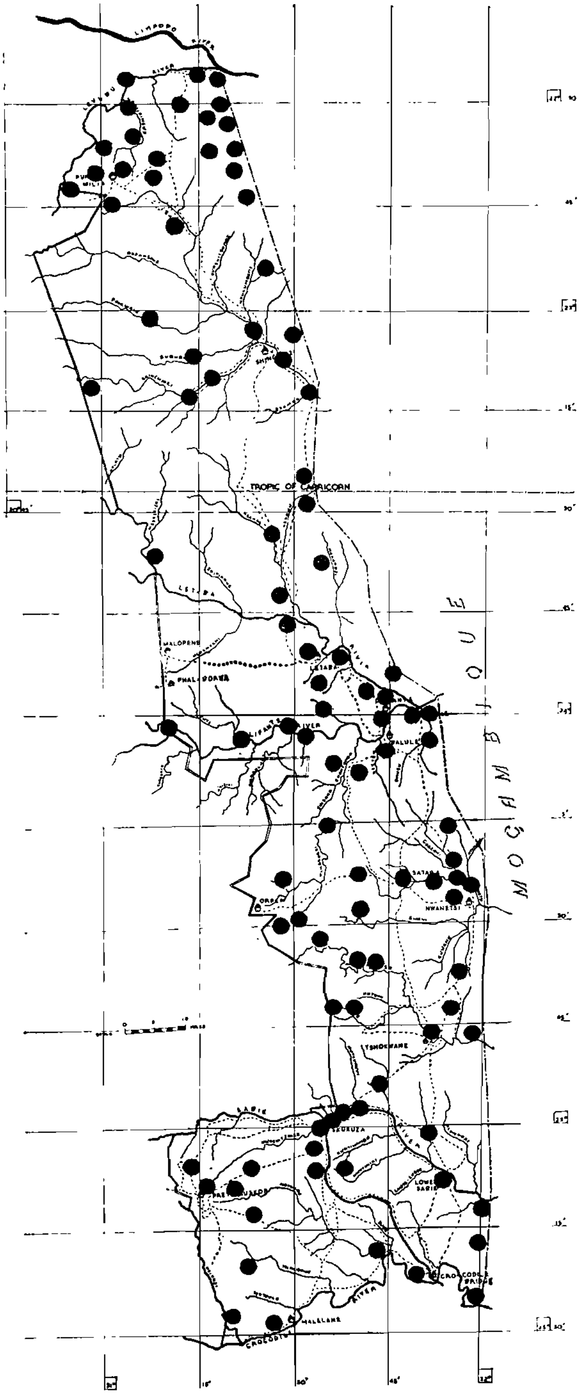

Fig. 2. Localities in the Kruger National Park from which terrestrial molluscs have been recorded.

Fig. 1 shows the general geographical position of the Kruger National Park and fig. 2 gives an indication of all blocks from which terrestrial molluscs are recorded in the present paper. These blocks are the following: S 7, 17, 22, 25, 28, 29, 33, 35, 36, 47, 51, 74, 77, 83, 97, 101, 107, 110; C 2, 3, 12, 24, 30, 31, 47, 52, 62, 69, 71, 72, 73, 77, 84, 85, 87, 88, 91, 100, 111, 112, 115, 125, 126, 130, 136, 138, 148, 154, 155, 162, 165; N 1, 5, 6, 8, 11, 13, 16, 19, 20, 22, 25, 27, 28, 30, 31, 33, 36, 38, 40, 46, 50, 75, 103, 107, 109, 115, 119, 122, 127, 136, 141, 171, 180, 187, 191, 209, 216, 225, 246, 247, 250, 257, 259, 260, 269, 272, 273, 276, 278, 279 (a total of 101 blocks). It thus reflects more or less the collecting activities of the various persons mentioned in the introduction.

Abbreviations used are K.N.P. for Kruger National Park, l/d for the ratio length/maximum diameter of a particular shell and NM for Natal Museum.

Gastropoda Prosobranchia

Family POMATIASIDAE

In the K.N.P. terrestrial prosobranchs are represented by only three species of the genus *Tropidophora*. One of these is among the commonest land molluscs in the game reserve and may be found almost everywhere in the area.

Tropidophora (*Ligatella*) *ligata* (Müller, 1774), fig. 3

Nerita ligata Müller, *Verm. terr. fluv. Hist.* **2**, p. 181, 1774 (type locality: not mentioned, very probably Cape Peninsula).

Tropidophora ligata; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 206, 1925; Germain, *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80**, p. 56, 1935; Wenz, *Handb. Paläozool.* **6**, 1, p. 534, fig. 1413, 1938; Connolly, *Ann. S. Afr. Mus.* **33**, p. 541, pl. 17, fig. 10, 1939; Franca, *Mem. Junta Invest. Ultram.* (2) **15**, p. 59, pl. 3, fig. 3, 1960.

K.N.P.: Skukuza staff village, S 7
Near Tlapa-la-Mokwena Dam, S 25
Tlapa-la-Mokwena, S 25
Near Lower Sabi Camp, S 33
Shithlave Kop, S 36
Sabipoort, S 47
Ship Mountain, S 51
Godleni, S 74
Beacon A, Lebombo Range, S 107
W. of Malelane Camp, S 110
Gorge and surroundings, C 2
Olifants R. Poort area, C 3
Along main road just S. of Olifants R., C 24
Nwanetsi Koppie, C 62
Between Semane Koppie and Ngirivane Windmill, C 69
Satara road W. of turn-off, C 84

Majekejekene Windmill, C 88
Nwaswitsontso Dam, C 111
Makonkolweni Spruit, C 115
Lindanda, C 130
Near Orpen Dam, C 136
Shingedzene, C 138
Koppie S. of koppie with Orpen plaque, C 148
Sand R. area, C 154
Sand R. area, C 155
Western end of Saliji Road, C 155
Sabi R. area, C 162
Saliji Road, rocky koppie, C 165
Hape Koppie, N 5
Shaluka, N 5
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Eastern boundary, patch of 'Msimbit' forest, N 6
Eastern boundary, border of sandveld and grey soil, N 13
Eastern boundary, grey soil, N 13
Madzaringwe Spruit, N 16
Shalungwa Spring, N 16
Saselandonga Poort, N 20
Near Malonga Spring, N 28
Dimbu W. of Punda Milia[1], N 30
Beacon III, eastern boundary, N 109
Ponda Hills, N 115
Tsange Koppie, N 136
Mooiplaas plots, N 187
Along Manyeleti past Ambandwini, N 209
N. of Olifants Camp after 2nd Mangwanduna junction, N 260
N. of Olifants Camp, N 272
Olifants Rest Camp, N 272
Mahulule Koppies, N 273
S. of Manyukelani, N 278
Junction Olifants and Mbulweni firebreaks, N 279

Tropidophora ligata is on the whole a well-defined species although a certain amount of variation, particularly in the shape of the shell, occurs throughout populations in the K.N.P. The following table of measurements shows that in the K.N.P. shells vary from

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[1] Formerly Punda Maria.

15·7-19·9 × 15·4-19·3 mm. (height × major diameter) and that the l/d varies from 0·96-1·11:

loc.	*measurements in mm.*	*l/d*	*loc.*	*measurements in mm.*	*l/d*
N 272	19·9 × 19·3	1·03	S 107	18·2 × 17·8	1·02
S 74	19·6 × 18·8	1·04	N 187	18·0 × 17·5	1·03
N 5	19·6 × 18·1	1·08	C 155	17·8 × 18·0	0·99
N 13	19·5 × 18·6	1·05	C 136	17·2 × 16·8	1·02
N 109	19·4 × 18·0	1·08	S 74	17·0 × 17·5	0·97
N 6	19·4 × 17·8	1·09	C 24	17·0 × 16·3	1·04
N 260	19·2 × 18·3	1·05	C 136	16·7 × 17·3	0·96
N 6	18·6 × 18·1	1·03	N 13	16·7 × 16·5	1·01
C 111	18·6 × 18·0	1·03	N 115	16·5 × 15·4	1·07
C 111	18·6 × 16·8	1·11	N 279	16·4 × 15·5	1·06
N 109	18·5 × 17·4	1·06	S 25	16·0 × 15·8	1·01
N 209	18·5 × 17·3	1·07	C 148	16·0 × 15·5	1·03
C 154	18·4 × 18·4	1·00	N 279	15·7 × 15·6	1·01
C 155	18·4 × 17·8	1·03			

The two shells from block N 279 have expanded and slightly reflected peristomes.

All types of pattern of the shell have been found in the K.N.P., but only a proper statistical study will be able to show whether patterns are indeed confined to or predominant in certain areas.

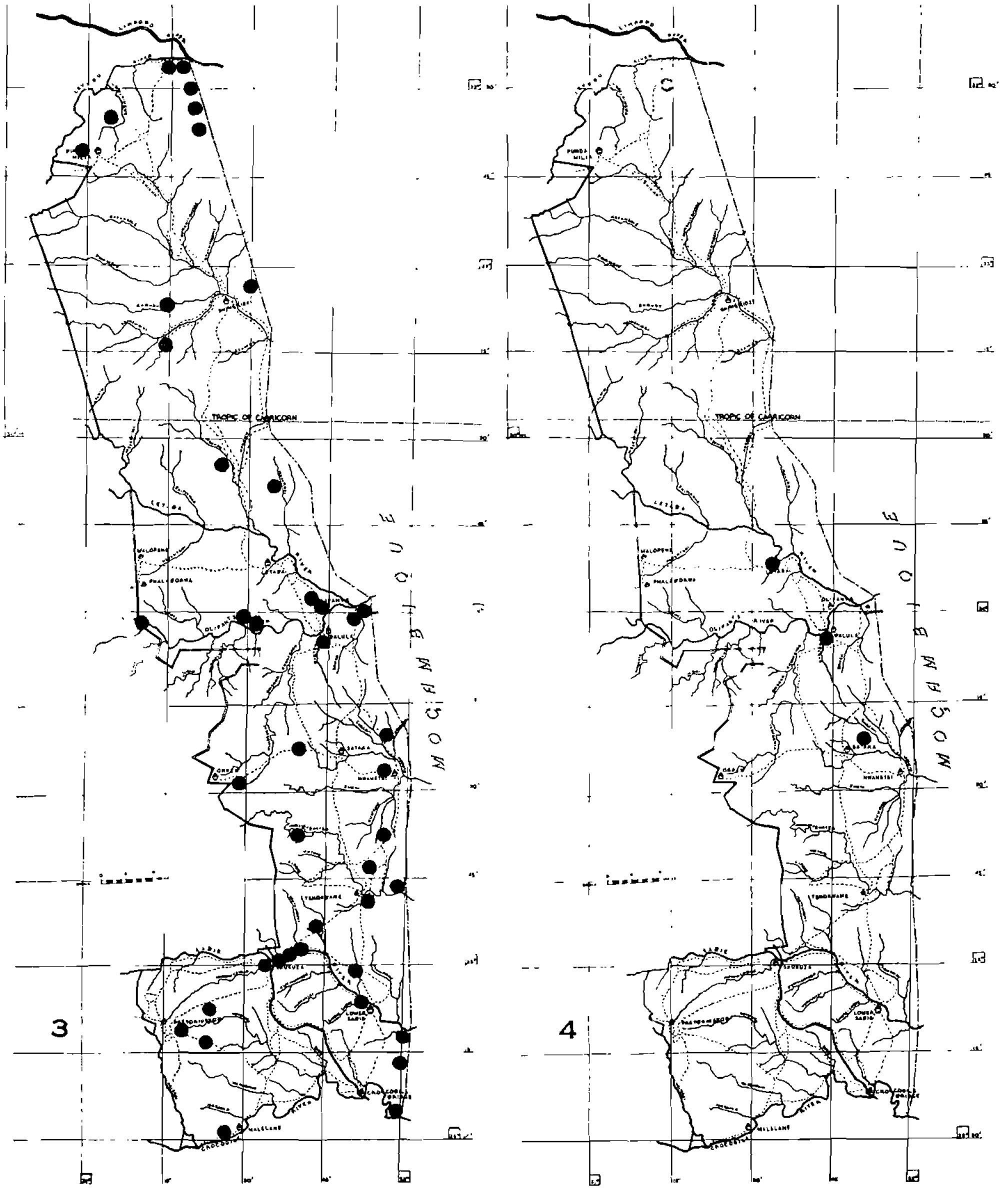
Altogether 179 specimens from the K.N.P. have been examined. These specimens have been divided into bandless and banded shells; in slightly weathered specimens the colour can usually be temporarily restored by moistening the shell, so that all available specimens have been taken into account.

In the southern area (S-blocks) a total of 29 shells was collected, of which 28 have bands and one is bandless. In the central area (C-blocks) a total of 90 specimens was collected, of which 84 have bands and 6 no pattern at all. Finally, in the northern area (N-blocks) a total of 60 specimens was collected, of which 26 show bands and 34 no pattern at all. This clearly shows that the bandless variety (var. *caffra* (Reeve) of certain authors) is rare in the south (only one against 28 banded shells), somewhat less rare in the central districts (one against 14 banded specimens) and dominant in the north (one against only 0·76 banded shells).

Very probably the intensity of the pattern in the present species is influenced by the rainfall, the bandless variety predominating in the low rainfall areas of the northern districts (15-20 inches per annum). In this context it is significant to draw attention to the one population in the northern area with very intensely marked shells, which was discovered in block N 30, west of the Punda Milia Rest Camp in the small area with an annual rainfall of 30-35 inches.

Identical problems are met with elsewhere in Africa and in Europe as well; the student is referred to Owen's paper (Owen, 1965) discussing polymorphism in small Achatinidae in Uganda.

T. ligata is widely distributed throughout Southern Africa from the Cape Peninsula



Figs. 3-4. Distribution in the Kruger National Park of 3. *Tropidophora ligata* (Müll.) and 4. *T. transvaalensis* (M. & P.).

northward, though it does not seem to venture far inland, only one record being known from the central districts of Southern Africa (Postmasburg, Griqualand West); the species also occurs in Southern Rhodesia (Mateke Hills, Natal and Transvaal Museums, *new record*) and is new to the K.N.P.

T. ligata was only once found in company of *T. transvaalensis* (M. & P.) (block C 24), which shows that apparently both species have slightly different ecological requirements, resulting in absence of competition for available niches.

Tropidophora (*Ligatella*) *transvaalensis* (Melvill & Ponsonby, 1891), fig. 4

Cyclostoma transvaalense Melvill & Ponsonby, *Ann. Mag. nat. Hist.* (6) **8**, p. 237, 1891 (type locality: Transvaal, Pretoria); *ibidem* (6) **9**, p. 94, 1892, pl. 5, fig. 6 (corrections of dimensions).

Tropidophora transvaalensis; Haas, *Abh. senckenb. Naturf. Ges.* **431**, pp. 33, 103, 1936; Connolly, *Ann. S. Afr. Mus.* **33**, p. 551, pl. 17, fig. 6, 1939.

K.N.P.: Along main road just S. of Olifants R., C 24
Shibotwane, C 72
Near Thambyi Spruit, Pafuri main road, N 11

Tropidophora transvaalensis was first mentioned for the K.N.P. by Haas in 1936, who recorded the present species from near Letaba (N 247), which locality has been incorporated in the map. It is indeed remarkable that Haas happened to collect the rarer of the main species of the genus *Tropidophora* in the K.N.P. So far it has only been recorded from a small number of localities in the Transvaal and one in the Cape Province.

Present material proves that *T. transvaalensis* is more variable than originally thought. A number of shells from block C 24 resembles material from Pretoria closely, although none in the K.N.P. has the continuous or almost free peristome of all 17 shells from Pretoria. The transverse sculpture is on the whole rather uniform, but the spiral ridges vary in strength and may rarely be rather faint at the periphery. The largest available shell measures 14·4 × 13·6 mm. (C 24).

T. transvaalensis accompanies *T. ligata* (Müll.) at the locality in block C 24, otherwise the species keep well separate. Obviously both have slightly different ecological requirements resulting in the absence of competition for available niches.

Tropidophora (*Ligatella*) spec. indet.

K.N.P.: Near Gudzane Dam, C 73
NW. of Olifants Camp, N 260

These two shells cannot as yet be identified as to species. Both have the well-marked spiral sculpture of the *insularis*-group, and an expanded and slightly reflected peristome. The transverse sculpture reminds one of that of *T. transvaalensis* (M. & P.); generally there is also some likeness to *T. nyassana* (Smith). The measurements are as follows:

Near Gudzane Dam, 13·3 × 13·7 mm.,
NW. of Olifants Camp, 17·3 × 18·6 mm.

Gastropoda Pulmonata

Family VERONICELLIDAE

Species of the family Veronicellidae are discussed in the chapter on slugs.

Family CHONDRINIDAE

Gastrocopta damarica (Ancey, 1888), fig. 5

Pupa damarica Ancey, *Naturaliste* **10**, p. 200, 1888 (type locality: Ovamboland, Disappointment Vlei). *Gastrocopta damarica;* Haas, *Abh. senckenb. naturf. Ges.* **431**, p. 23, 1936; Zilch, *Arch. Moll.* **71**, p. 221, figs. 11-12, 1939; Connolly, *Ann. S. Afr. Mus.* 33, p. 374, 1939; Adam, *Vol. Jubil. Victor van Straelen*, p. 796, figs. 19 (i-j), 20 (f), 1954.

K.N.P.: Shilowa Koppie, N 180

Gastrocopta damarica is widely distributed throughout Southern Africa; it is therefore rather surprising that so far only two shells of this species have been found in the K.N.P. A number of records for the Transvaal is available and it is confidently expected that it will appear to have a much wider distribution in the K.N.P.; the species is new to the game reserve.

Gastrocopta thomasseti Pilsbry, 1929, fig. 5

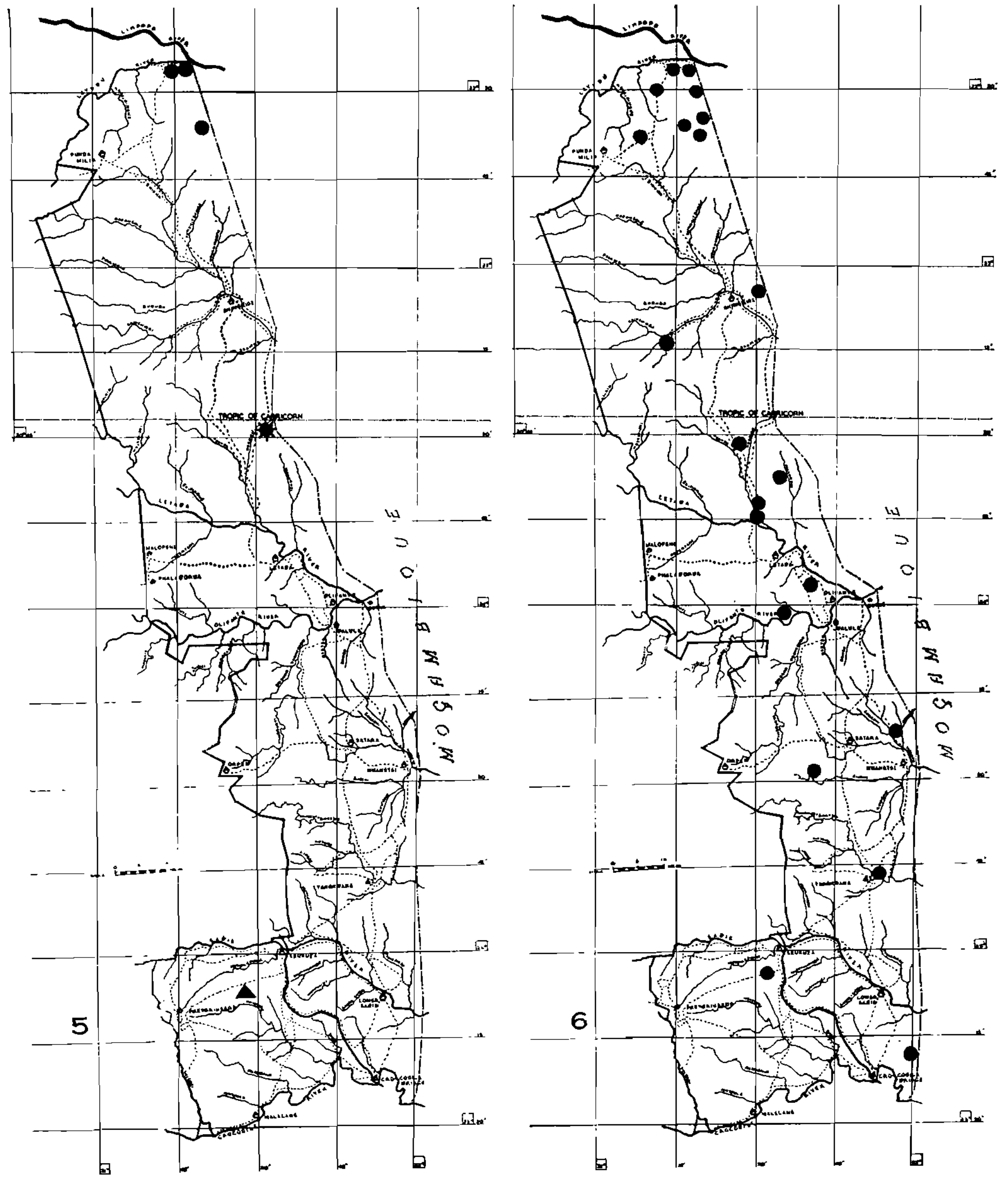
Gastrocopta thomasseti Pilsbry, *Ann. Natal Mus.* **6**, p. 301, pl. 20, figs. 5-6, 1929 (type locality: Block Island, Weenen, Natal); Connolly, *Ann. S. Afr. Mus.* 33, p. 376, 1939.

K.N.P.: Pafuri picnic spot, N 5
Limpopo-Levubu R. junction, N 6
Near Malonga Spring, N 28

Only a few specimens of *Gastrocopta thomasseti* have so far been found in the K.N.P.; all were compared with paratypes in the Natal Museum and found to agree well except in minor details. The Pafuri shell is slightly more obese than the paratypes and the angular lamella is only slightly bifid; the Malonga specimen has five whorls and measures 2·25 × 1·0 mm., while the angular lamella is hardly bilobed. The specimen from the Limpopo-Levubu Rivers junction has a supra-palatal fold in the aperture.

G. thomasseti was up to now only known from the type locality in Natal; it is therefore rather surprising to find it in the K.N.P. Apparently it seems to prefer a low rainfall (15-20 inches per annum) and comparatively high temperatures. On the other hand the distribution of minute species is much influenced by their passive dispersal. "In all regions it is mainly the minute forms that exhibit wide distribution. This is pertinent on generic as well as specific levels." (Waldén, 1963, p. 162). Many of Southern Africa's smallest species indeed seem to be widely distributed.

The species is new to both the Transvaal and the K.N.P.; the specimens from blocks N5 and N 6 were obtained from leaf litter under trees.



Figs. 5-6. Distribution in the Kruger National Park of 5. *Gastrocopta damarica* (Anc.) (star), *G. thomasseti* Pils. (dots) and *Pupilla fontana* (Krss.) (triangle); 6. *Pupoides calaharicus* (Bttg.)

Family PUPILLIDAE

Pupilla (Gibbulinopsis) fontana (Krauss, 1841), fig. 5

Pupa fontana Krauss, *Küster Conch. Cab.* p. 122, pl. 16, figs. 9-12, 1841 (type locality: Source of Mooi River, Transvaal).

Pupilla fontana; Connolly, *Ann. S. Afr. Mus.* 33, p. 391, pl. 12, fig. 13, 1939.

K.N.P.: Shithlave Kop, S 36

So far only one specimen of *Pupilla fontana* has been collected in the K.N.P.; it is small, but adult, and measures 2·6 mm. with 6 whorls. This species, new to the K.N.P., is widely distributed throughout southern and eastern Africa, although still unknown in Central Africa (see e.g., Adam, 1954).

Pupoides calaharicus (Boettger, 1886), figs. 6-8

Buliminus (Leucochiloides) calaharicus Boettger, *Ber. senckenb. naturf. Ges.* 1885/6, p. 24, pl. 2, fig. 3, 1886 (type locality: Ghous, Cape Province).

Pupoides calaharicus; Connolly, *Ann. S. Afr. Mus.* 33, p. 395, 1939; Zilch, *Arch. Moll.* **71**, p. 220, fig. 3, 1939.

Pupoides coenopictus (Hutton); Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 164, 1925.

K.N.P.: Nahpe Road, S 17
Godleni, S 74
Near Gudzane Dam, C 73
Sweni firebreak, C 91
Near Orpen Dam, C 136
Hape Koppie, N 5
Shaluka, N 5
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Near Thambyi Spruit, Pafuri main road, N 11
Eastern boundary, border of sandveld and grey soil, N 13
Eastern boundary, grey soil, N 13
Eastern boundary, N. of Saselandonga Poort, N 20
Near Klopperfontein Dam, N 25
Near Machayi Pan, N 27
Near Malonga Spring, N 28
Beacon III, eastern boundary, N 109
Tsange Koppie, N 136
Mooiplaas plots, N 187
Along Manyeleti past Ambandwini, N 209
Tsende plots, N 216
Koppie N. of Letaba R. causeway, N 225
Shithaburi, N 259
Junction Olifants and Mbulweni firebreaks, N 279

Pupoides calaharicus is in many respects a puzzling species. In Southern Africa three nominal species are recognised; they are widely spread, mainly throughout the drier parts of the subregion, being known from the Cape Province, South West Africa, Bechuanaland, the Transvaal, Zululand, Southern Rhodesia and Mozambique. Other 'species' extend from East Africa and the Arabian Peninsula into India, while still others occur in West Africa (see e.g., Verdcourt, 1958). All apparently prefer arid or semi-arid areas. The systematic position of all these 'species' is not clear, apart from the fact that many are very probably closely allied to one another (see Pilsbry, 1921, and Verdcourt, *op. cit.*), and it has been suggested that they belong to one widely spread and variable species for which the oldest available name is *Pupa coenopicta* Hutton, 1834 (type locality: Beeana near Agra, India).

The oldest name available for the Southern African forms is *Buliminus calaharicus* Boettger, 1886, the type of which has been figured by Zilch (1939). The present author prefers for the time being to hold a conservative view and retain the name *Pupoides calaharicus* for the sake of convenience only.

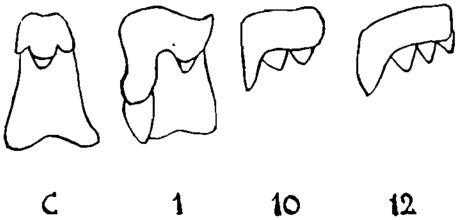
The species is very variable, both large and small shells with convex and flat whorls and varying apertures having been collected in the K.N.P. However, all forms are connected by intermediates in the same population, reason for considering the K.N.P. material to belong to one single species. In the K.N.P. the shells are never large, the maximum measurements being 5·7 × 2·5 mm. (specimens from Beacon III and Saselandonga Poort), while other large specimens measure 5·6 × 2·5 mm. (near Klopperfontein Dam) and 5·4 × 2·5 mm. (Saselandonga Poort).

In the author's experience live *Pupoides calaharicus* occur in colonies in sheltered spots; one colony was found in May 1962 under logs of *Combretum imberbe* Wawra (fam. Combretaceae) near Machayi Pan and another very populous one on 22.II.1964 under a couple of large stones near Gudzane Dam. The latter colony contained a fair number of juveniles of which the smallest is about 2 mm. long with 3 whorls; none of the adults is longer than 5 mm. Among this colony some specimens of *Gulella infans* (Crvn.) were found, no doubt preying on the multitude of *Pupoides* snails. In the dormant stage these snails have a very characteristic epiphragm, which is almost circular and to which adhere grains of soil and sand.

Pupoides calaharicus is new to the K.N.P.

The animal is black. Radula and jaw were extracted from a specimen from near Gudzane Dam. The only description and figures of these available to the author are those of Jickeli (1874, pl. II, fig. 1). The radula of the K.N.P. specimen (fig. 7) measures approximately 1·0 × 0·4 mm. and has about 82 transverse rows; this agrees well with Jickeli's data (0·875 × 0·275 mm., 80 rows). However, the formula of the K.N.P. specimen is 12—1—12 (25 teeth in every row), while Jickeli records a total of 61. He figures only examples of the central tooth and 1st, 10th and 13th teeth; thus very probably his number of 61 is wrong.

The jaw (fig. 8) has a length of about 0·4 mm. (Jickeli 0·325 mm.).



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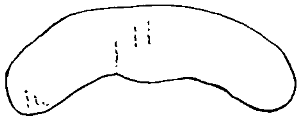

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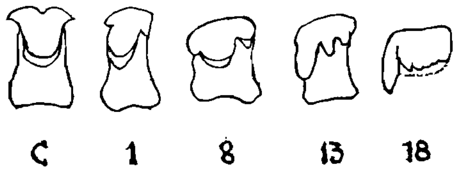

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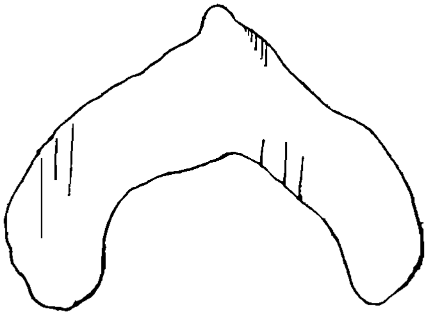

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Figs. 7-10—7-8. *Pupoides calaharicus* (Bttg.) from near Gudzane Dam, 7. Radula elements; 8. Jaw, actual span 0·4 mm.; 9-10. *Rachis jejuna* (M. & P.) from Sand River area, 9. Radula elements; 10. Jaw actual span 0·7 mm. All figures highly enlarged.

Family ENIDAE

Rachis jejuna (Melvill & Ponsonby, 1893), figs. 9-11

Buliminus (*Pachnodus*) *jejunus* Melvill & Ponsonby, *Ann. Mag. nat. Hist.* (6) **12**, p. 106, pl. 3, fig. 7, 1893 (type locality: Northern Transvaal).
Rhachis jejuna; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 160, pl. 4, fig. 21, 1925.
Rachis jejuna; Connolly, *Ann. S. Afr. Mus.* **33**, p. 436, pl. 13, fig. 2, 1939.
Rachis punctatus Anton; Germain, *Mem. Est. Mus. Zool. Univ. Coimbra* (1) **80**, p. 25, 1935 (*R. jejuna* synonym of *R. punctata*).

K.N.P.: Four miles along Nahpe Road, S 17
Gorge and surroundings, C 2
Along main road just S. of Olifants R., C 24
Shibotwane, C 72
Nwanetsi Rest Camp, C 85
Makonkolweni Spruit, C 115
Sand R. area, C 154
Sand R. area, C 155
Along main road N. of Sabi R., C 162

Eastern boundary, N. of Saselandonga Poort, N 20
Beacon III, eastern boundary, N 109
Ponda Hills, N 115
Mooiplaas plots, N 187
Tsende plots, N 216
NW. of Olifants Camp, N 260
N. of Olifants Camp before 2nd Mangwanduna junction, N 260
Do., after 2nd Mangwanduna junction, N 260
Junction Olifants and Mbulweni firebreaks, N 279

Rachis jejuna is widely distributed throughout Zululand, the Transvaal, Mozambique and S. Rhodesia; it is new to the K.N.P. In the game reserve it is widely distributed and usually found in long grass or in the cracks of the bark of trees, although never higher than a couple of feet. On the island between the Sabi and Sand Rivers this species was found in diapause on trees on 26.IV.1962; the majority were juvenile specimens of which the shells were closed by an epiphragm. Notwithstanding unseasonal though fairly heavy rains on that day, none of these emerged to crawl around.

Some measurements of adult shells are as follows:

Sand R. area, C 154	17·0 × 7·5 mm.
	16·3 × 7·4 mm.
Sand R. area, C 155	16·5 × 7·3 mm.
Saselandonga Poort	16·0 × 6·6 mm.
Mooiplaas plots	18·6 × 8·2 mm.
	16·7 × 7·6 mm.
Olifants-Mbulweni firebreaks	16·4 × 7·0 mm.

The radula of a specimen from the Sand River area (block C 154) measures 1·0 × 1·6 mm. and has approximately 68 transverse rows. The formula is 23—1—23. The teeth (fig. 9) are of the usual type found in the family Enidae. The jaw (fig. 10) is bent like an arc and has a maximum span of 0·7 mm.

Conulinus[2] *mcbeanianus* (Burnup, 1905), figs. 12-15

Ena (Pachnodus) mcbeaniana Burnup, *Proc. mal. Soc. Lond.* **6**, p. 302, pl. 16, figs. 1-2, 1905 (type locality: Transvaal, Pretoria District).

Edouardia mcbeaniana; Connolly, *Ann. S. Afr. Mus.* **33**, p. 426, pl. 13, fig. 30, 1939.

K.N.P.: Numbi Koppie, S 22
Near Lower Sabi Camp, S 33
Manung Koppie, S 35
Shabin Koppie, S 35
Shithlave Kop, S 36
Ship Mountain, S 51

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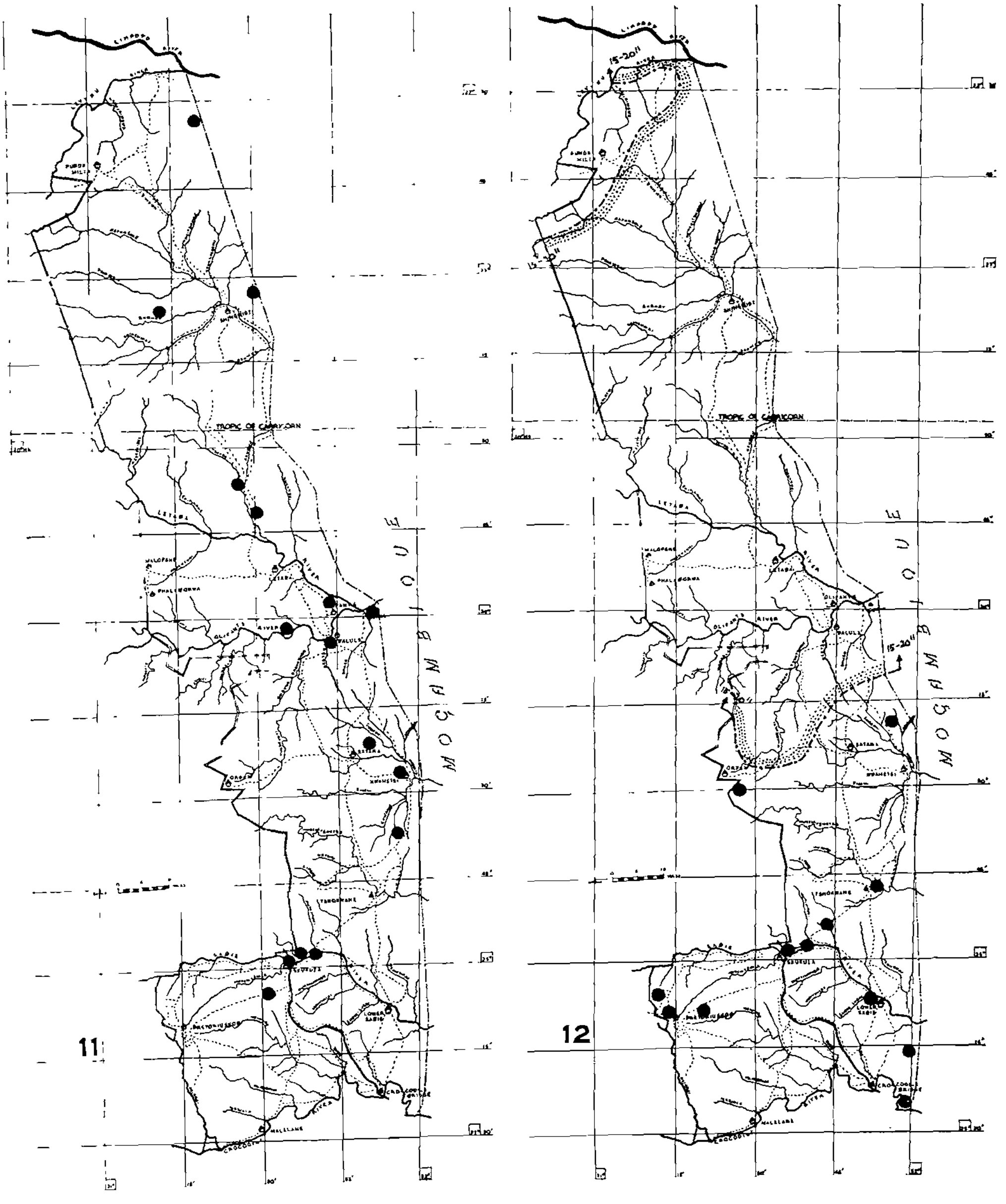
[2] There is no consensus of opinion on the use of *Conulinus* von Martens, 1895, or *Edouardia* Gude, 1914. Reference should be made to Connolly (1939, p. 421); the present author has merely followed Zilch (1959, p. 194).



Figs. 11-12. Distribution in the Kruger National Park of 11. *Rachis jejuna* (M. & P.) and 12. *Conulinus mcbeanianus* (Bnp.), the zone with a mean annual rainfall of 15-20 inches has been delimited by dotted lines.

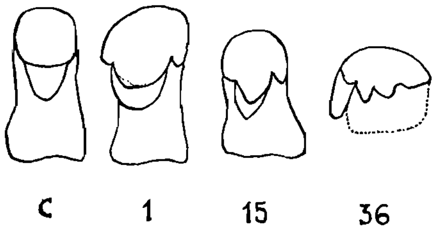
Godleni, S 74
Beacon A, Lebombo Range, S 107
Nwanetsi Koppie, C 62
Nwaswitsontso Koppies, C 87
Near Orpen Dam, C 136
Koppie S. of koppie with Orpen plaque, C 148
Along Sabi R., C 155
Sabi R. area, C 162

Conulinus mcbeanianus, new to the K.N.P., usually occurs on trees in sheltering types of vegetation, such as riverine forest, thick bush on rocky koppies (Pretoriuskop District), etc. The distribution in the K.N.P. seems mainly restricted to the area south of the Nwanetsi River (fig. 12). Apparently this species avoids the 15-20″ rainfall belt which is here characterized by the Mopani veld type of vegetation; this is in full accordance with other records of the species elsewhere in the Transvaal (see fig. 15, incorporating Natal Museum specimens from Rustenburg as a *new record*).

The shell of *C. mcbeanianus* is easily recognized, particularly by its rounded periphery; juvenile shells are slightly angulate at the periphery. The shape varies considerably; on the strength of more abundant material Connolly's var. *lemaneensis* seems to fall within the normal variation of the species. This is well illustrated by the following series of measurements:

Sabi R. area	13·7 × 10·1 mm., l/d 1·36
Cotype in Natal Museum	15·7 × 11·2 mm., l/d 1·40
var. *lemaneensis* ex Connolly, 1939	16·1 × 11·2 mm., l/d 1·44
along Sabi R.	16·0 × 13·3 mm., l/d 1·20
Nwanetsi Koppies	16·8 × 13·7 mm., l/d 1·23
Koppie S. of koppie with Orpen plaque	16·8 × 14·1 mm., l/d 1·19

Consequently it seems advisable to consider the var. *lemaneensis* not to differ from typical *C. mcbeanianus;* therefore the name can be deleted.



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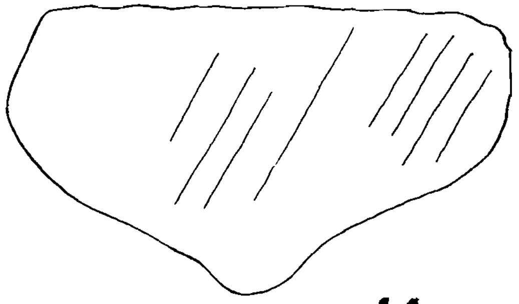

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Figs. 13-14. *Conulinus mcbeanianus* (Bnp.) from koppie S. of koppie with Orpen plaque, 13. Radula elements; 14. Jaw, actual span 0·7 mm. All figures highly enlarged.

The radula of a specimen from block C 148 measures 3·5 × 1·7 mm. and has approximately 130 transverse rows. The teeth (fig. 13) resemble those of *C. spadicea* (Pfr.) and *C. arenicola* (Bens.) as figured by Connolly (1939, figs. 35-36); the formula is 44—1—44. The thin jaw (fig. 14) is only 0·7 mm. long and has a well-marked oblique sculpture.

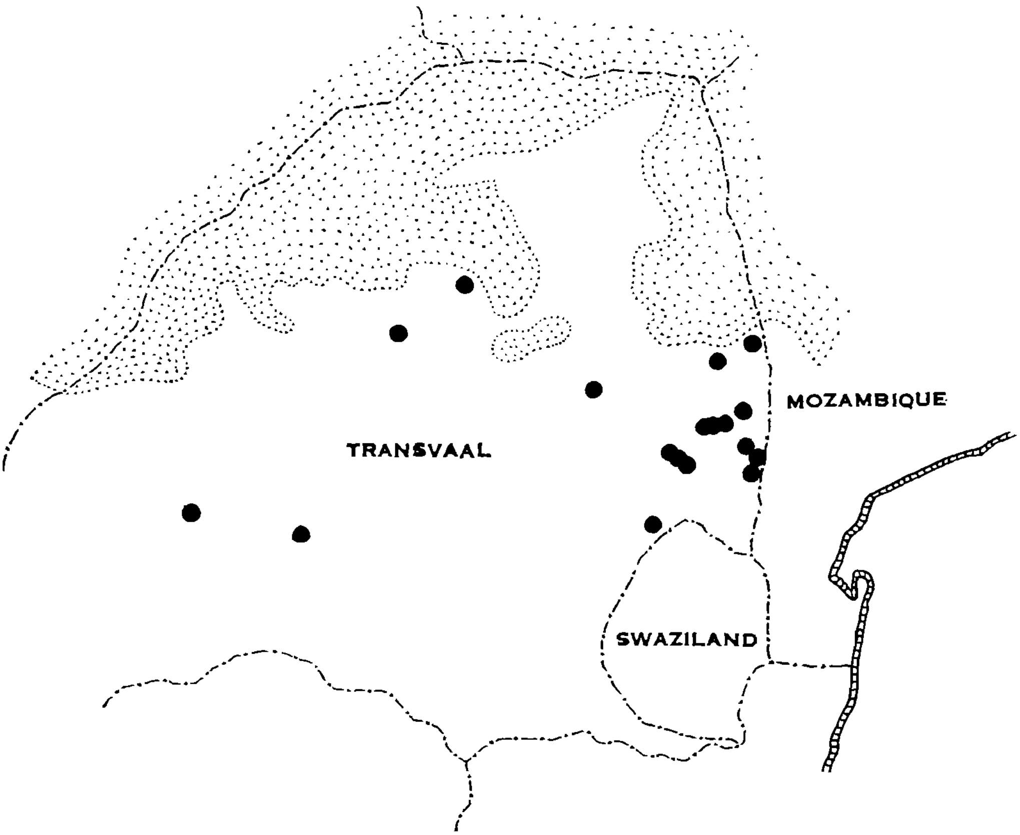


Fig. 15. General distribution of *Conulinus mcbeanianus* (Bnp.). The shaded area depicts the zone with 15-20 inches mean annual rainfall.

Conulinus metuloides (Smith, 1899), fig. 16

Buliminus (Conulinus) metuloides Smith, *Proc. zool. Soc. Lond.* 1899, p. 587, pl. 33, fig. 43, 1899 (type ocality: Nyasaland, Zomba).
Conulinus metuloides; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 154, 1925.
Edouardia metuloides; Connolly, 1939, *Ann. S. Afr. Mus.* **33**, p. 433, pl. 13, fig. 16, 1939.

K.N.P.: Shalungwa Spring, N 16
Nyandu firebreak road, N 46
Mahulule Koppies, N 273

Conulinus metuloides is new to South Africa, the Transvaal and the K.N.P.; up to now its southernmost known localities were on and a short distance south of the Zambezi River, so that the range is now extended to south of the Limpopo. It is not always easy to distinguish this species from its nearest ally, *C. sordidulus* (Mts.); usually *C. metuloides* has more convex whorls and its l/d varies from 1·71—1·90, indicating that it is never as slender as *C. sordidulus* (Mts.), which has an l/d from 1·94—2·11.

The following measurements may be compared with those given under *C. sordidulus* (Mts.):

Shalungwa Spring	9·3 × 5·0 mm., l/d 1·86, 6 whorls
Mahulule Koppies	9·3 × 4·9 mm., l/d 1·90, 6 whorls
Nyandu firebreak road	8·9 × 5·2 mm., l/d 1·71, 5½ whorls
Victoria Falls (NM)	9·2 × 5·3 mm., l/d 1·73, 6¼ whorls
Connolly, 1939	12·5 × 6·6 mm., l/d 1·89, 7½ whorls

The specimen from the Nyandu firebreak road was collected by Dr. R. F. Lawrence "under bark of rare tree". Like all other species of *Conulinus* this is a tree dweller which collects dirt on its shell, resulting in a very effective camouflage, which very probably has survival value against attacks by birds.

Conulinus sordidulus (von Martens, 1897), fig. 17

Buliminus (*Rhachis*) *sordidulus* von Martens, *Deutsch Ost. Afr.* **4**, *Besch. Weicht.*, p. 65, pl. 3, fig. 30, 1897 (type locality: Kenya, Ndi (Taita Hills), and Kitui).

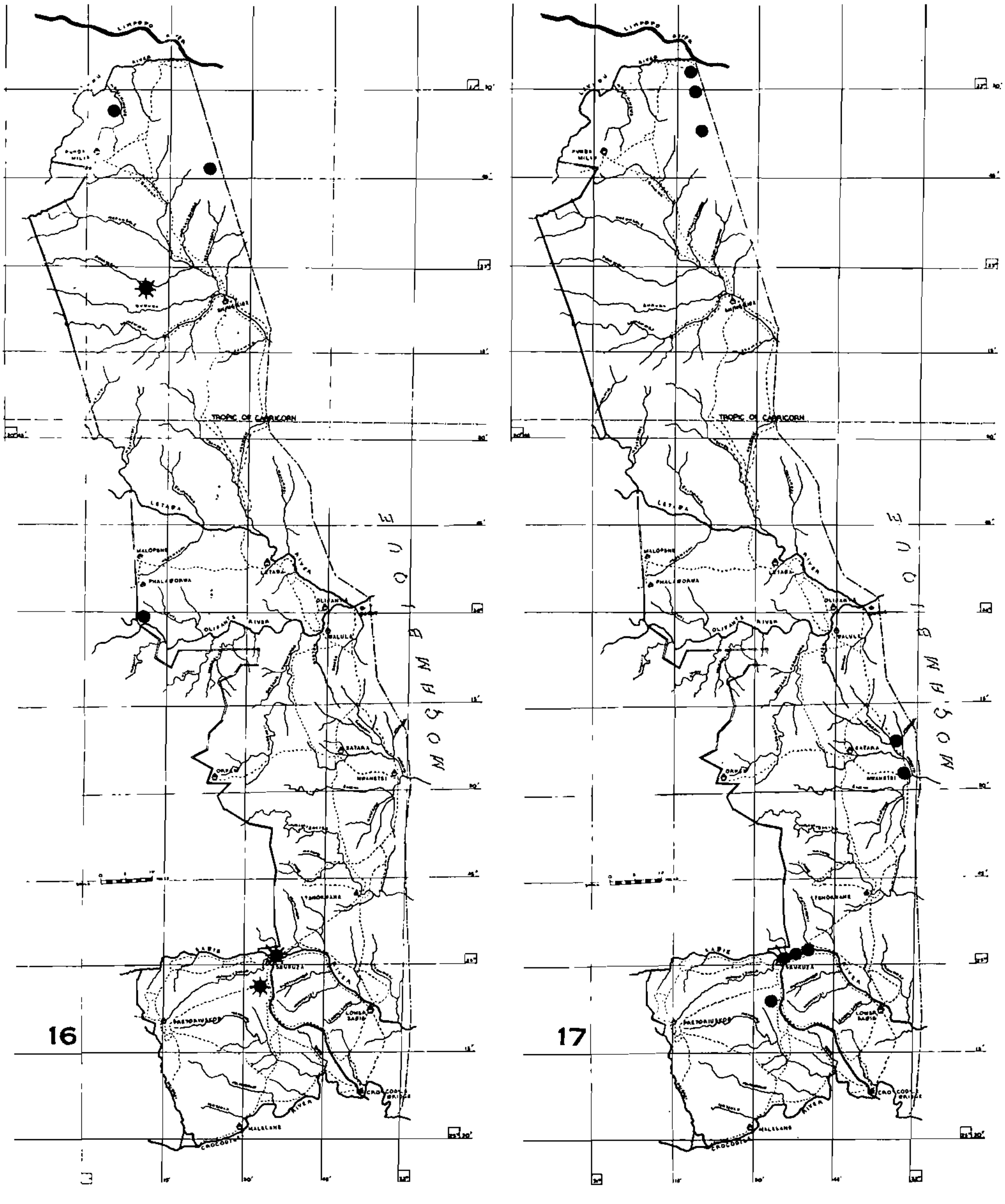
Conulinus sordidulus; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 154, pl. 4, fig. 19, 1925.

Edouardia sordidula; Connolly, *Ann. S. Afr. Mus.* **33**, p. 432, pl. 13, fig. 10, 1939.

K.N.P.: Skukuza Koppies, S 28
Near Gudzane Dam, C 73
Nwanetsi Rest Camp, C 85
Sand R. area, C 154
Sand R. area, C 155
Sabi R. area, C 162
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Eastern boundary, grey soil, N 13
Near Malonga Spring, N 28

Conulinus sordidulus is new to both the Transvaal and the K.N.P. It is fairly common in the K.N.P. and widely distributed. For comparison with *C. metuloides* (Smith) some measurements are given below:

Sand R. area, C 155	12·4 × 5·8 mm., l/d 2·14, 7 whorls
	11·8 × 5·6 mm., l/d 2·11, 6½ whorls
Eastern boundary, N 13	11·6 × 5·3 mm., l/d 2·19, 7 whorls
Malonga	11·5 × 5·7 mm., l/d 2·02, 6½ whorls
	9·2 × 4·6 mm., l/d 2·00, 6¼ whorls
Near Gudzane Dam	9·3 × 4·8 mm., l/d 1·94, 6½ whorls
Nuanetsi R. banks, Moz. (NM)	10·5 × 5·0 mm., l/d 2·10, 6½ whorls
Connolly, 1939	10·3 × 5·2 mm., l/d 1·98, 6½ whorls



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Figs. 16-17. Distribution in the Kruger National Park of 16. *Conulinus metuloides* (Smith) (dots) and *C. transvaalensis* (M. & P.) (stars); 17. *C. sordidulus* (Mts.).

The Nuanetsi River banks (Mozambique) specimen in the Natal Museum is very probably the one mentioned by Connolly (1939, p. 433); this shows a slight difference in measurements due to instruments and individual measuring of the shell in question.

Conulinus transvaalensis (Melvill & Ponsonby, 1893), fig. 16

Buliminus transvaalensis Melvill & Ponsonby, *Ann. Mag. nat. Hist.* (6) **12**, p. 105, pl. 3, fig. 6, 1893 (type locality: Northern Transvaal).
Conulinus transvaalensis; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 154, 1925.
Edouardia transvaalensis; Connolly, *Ann. S. Afr. Mus.* **33**, p. 434, pl. 13, fig. 11, 1939.

K.N.P.: Nahpe Road, S 17
Sabi R. area, C 162
Near Phugwane R., N 103

Conulinus transvaalensis is the smallest species of the genus in Southern Africa; so far it is only known from some widely scattered localities in the Northern and Eastern Transvaal and on the border of Mozambique. Therefore its occurrence in the K.N.P. is no surprise; it is by no means common and only four specimens have been obtained. *C. transvaalensis* is new to the K.N.P.

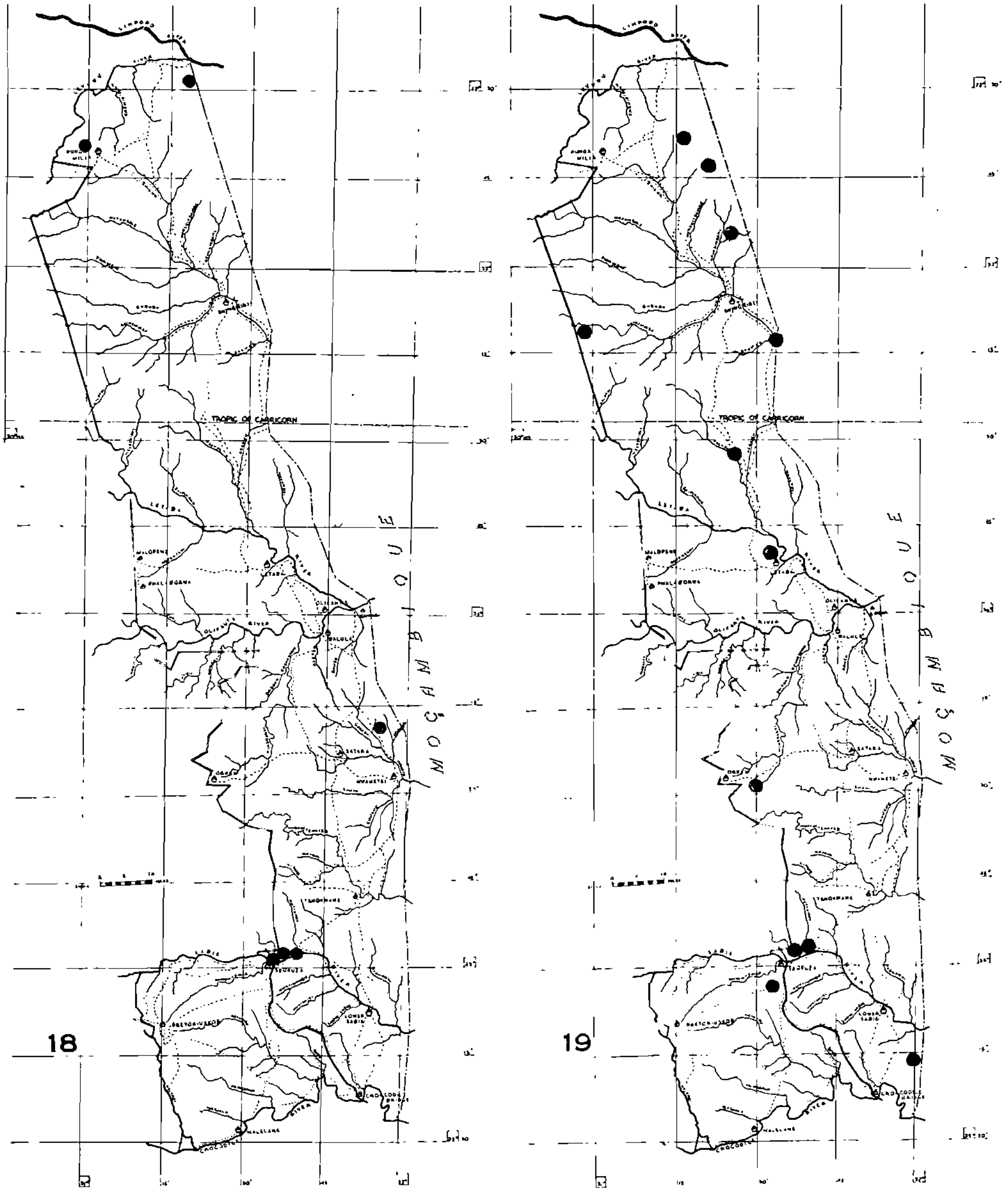
Rhachistia sticta (von Martens, 1859), fig. 18

Bulimus (Rhachis) stictus von Martens, *Malak. Blätt.* **6**, p. 211, pl. 2, fig. 6, 1859 (type locality: Mozambique, Tette).
Rhachistia sticta; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 164, 1925; Germain, *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80**, p. 35, 1935; Connolly, *Ann. S. Afr. Mus.* **33**, p. 419, pl. 13, fig. 19, 1939.

K.N.P.: Nwanetsi Koppie, C 62
Sand R. area, C 154
Sand R. area, C 155
Sabi R. area, C 162
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Matukwane Drift, N 30
Matukwane Hills, N 30

Rhachistia sticta is new both to the Transvaal and the K.N.P. Certain features of this species may give rise to confusion as far as identification is concerned. The periphery of the body whorl may be both angulate and rounded in juvenile as well as fully adult shells. Both types of shell occur however in the same population, but usually the colour pattern is sufficiently diagnostic to recognize the species. The author submitted specimens to Dr. B. Verdcourt for his opinion; he agreed with Connolly (1939) that both forms belong to *R. sticta*, but in the absence of spirits material this still seems open to doubt. The systematics of the 'coloured' Enidae of East Africa are in need of revision, so that no further comments could be made.

The largest available shells are damaged specimens from Nwanetsi Koppie, having



Figs. 18-19. Distribution in the Kruger National Park of 18. *Rhachistia sticta* (Mts.) and 19. *Succinea africana* Krss.

reached at least 26·0 and 26·5 mm. respectively. The measurements of some other adults are given below:

Sand R. area (C 154)	22·5 × 12·4 mm.
Eastern boundary	23·5 × 12·7 mm.
Matukwane Hills	23·5+ × 13·0 mm. (apex and lip damaged)

The 'coloured' Enidae are widely distributed in East Africa (with a few representatives further west) and SW. Asia; their southern limit of distribution is reached in Zululand and no species is known to occur south of the Tugela River. In Southern Africa they are restricted to a fairly narrow strip on the east coast and the records from the K.N.P. represent the western limits of the group in the subcontinent.

Family SUCCINEIDAE

It is usually not possible to identify species of this family on shells only. Fortunately, the shells of some South African species are fairly characteristic so as to allow one to obtain reasonably accurate identifications. Although many species of Succineidae are known to be amphibious in their habits, a certain number has adapted themselves to dry and even arid conditions. Stunted growth may probably be caused by a dry habitat and indeed none of the shells from the K.N.P. seems to reach the size of specimens from areas with a higher rainfall and humidity.

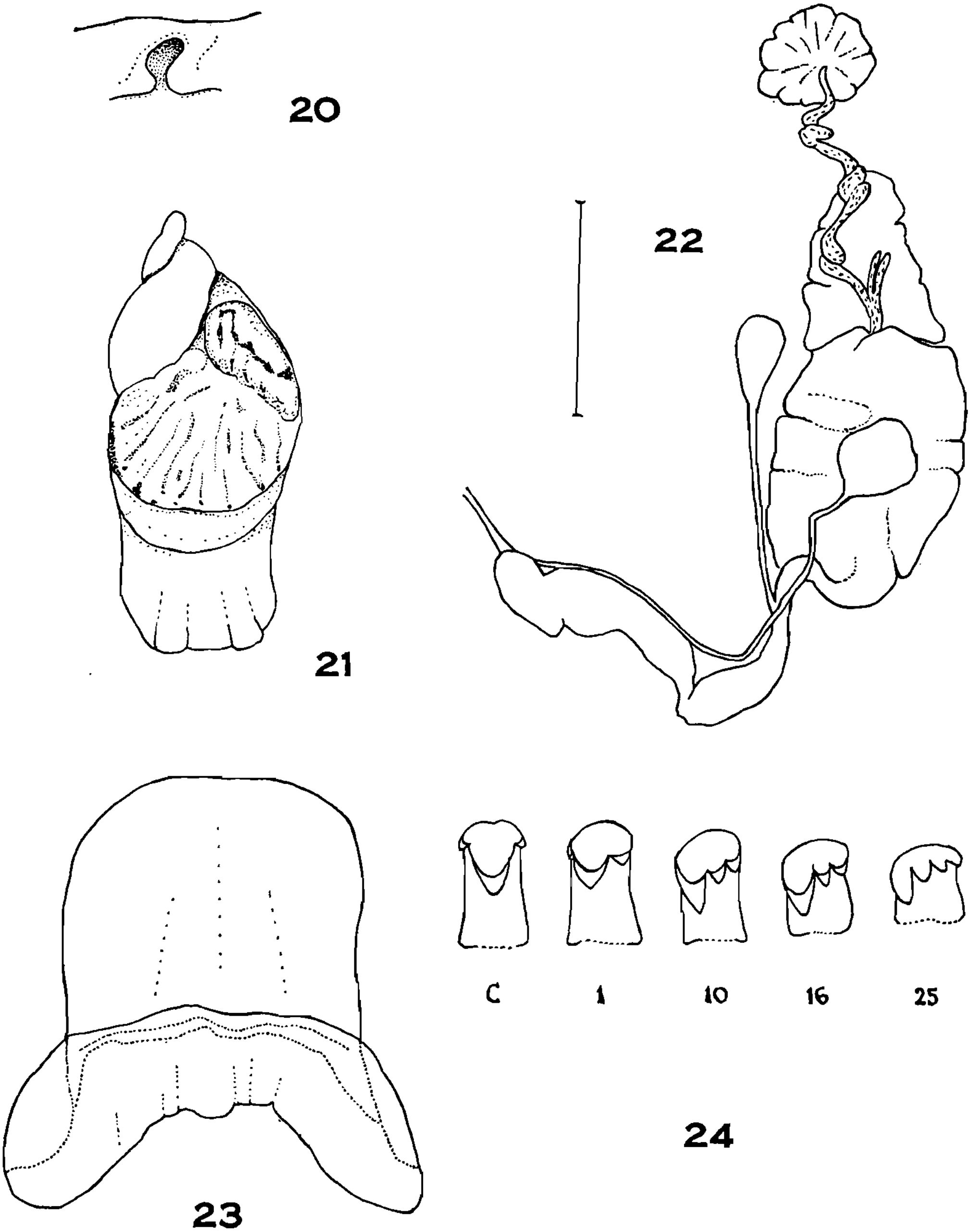
Succinea africana Krauss, 1848, figs. 19-24

Succinea amphibia Drap. var. *africana* Krauss, *Südafr. Moll.*, p. 73, 1848 (type locality: Transvaal, Limpopo River banks).

Succinea africana; Haas, *Abh. senckenb. naturf. Ges.* **431**, p. 20, 102, 1936; Connolly, *Ann. S. Afr. Mus.* **33**, p. 440, pl. 15, figs. 1-2, 1939.

K.N.P.: Nahpe Road, S 17
Godleni, S 74
Majekejekene Windmill, C 88
Sand R. area, C 154
Sand R. area, C 155
Near Machayi Pan, N 27
Between Mahlakuza and Shimuwene Pans, N 36
Shingomeni, N 75
Shangoni Koppies, N 122
Eastern boundary just N. of Shingwedzi R., N 141
Shipandane Drift, Tsende R., N 187

Succinea africana has already been mentioned by Haas (1936) from near the Letaba Rest Camp (N 247); this record has been incorporated in the map (fig. 18). This species has so far only been recorded from the Eastern and Northern Transvaal and the Victoria Falls. The specimens from block N 27 were collected alive under logs of *Combretum imberbe* Wawra.



Figs. 20-24. *Succinea africana* Krss. from near Machayi Pan, 20. Respiratory orifice and body-lobes; 21. Animal removed from shell; 22. Genitalia, scale 4 mm.; 23. Jaw, actual size 0·8 × 0·9 mm.; 24. Radula elements. All figures highly enlarged.

The shells are rather featureless but usually very regular in shape. The following are measurements of adult shells:

Godleni	12·1 × 7·1 mm., l/d 1·70
N 141	11·4 × 6·8 mm., l/d 1·68
Near Machayi Pan	11·1 × 6·5 mm., l/d 1·71
Shangoni	11·0 × 6·5 mm., l/d 1·69
Near Machayi Pan	11·0 × 6·3 mm., l/d 1·75
Shipandane Drift	10·2 × 6·1 mm., l/d 1·67

Specimens from near Machayi Pan were collected alive and one of these has been dissected in order to give particulars of the anatomy of the species.

The jaw (fig. 23) is golden brown and measures 0·8 × 0·9 mm. The median projection is very short and rounded; there are hardly any traces of lateral folds. The radula (fig. 24) measures about 2 × 1 mm. and has approximately 75 rows of teeth arranged in the following formula: 15—10—1—10—15. A transverse row may be described as follows: the lateral teeth form a fairly straight line together with the central tooth, while the marginal teeth also form a fairly straight line which ascends slightly obliquely from the line of the lateral teeth. The central tooth is slender and not very wide and has a fairly short mesocone and two small ectocones. The first lateral is also tricuspid, having a fairly large mesocone, a very small endocone and a larger ectocone; the next few lateral teeth are all more or less the same. The marginals are irregularly dentated, squarish and smaller than the lateral teeth.

The mantle (fig. 21) is marbled with greyish black patches, which are particularly marked at the margin. The kidney also shows well-marked dark patches on the surface. There is no colour pattern or pigmentation on head and foot.

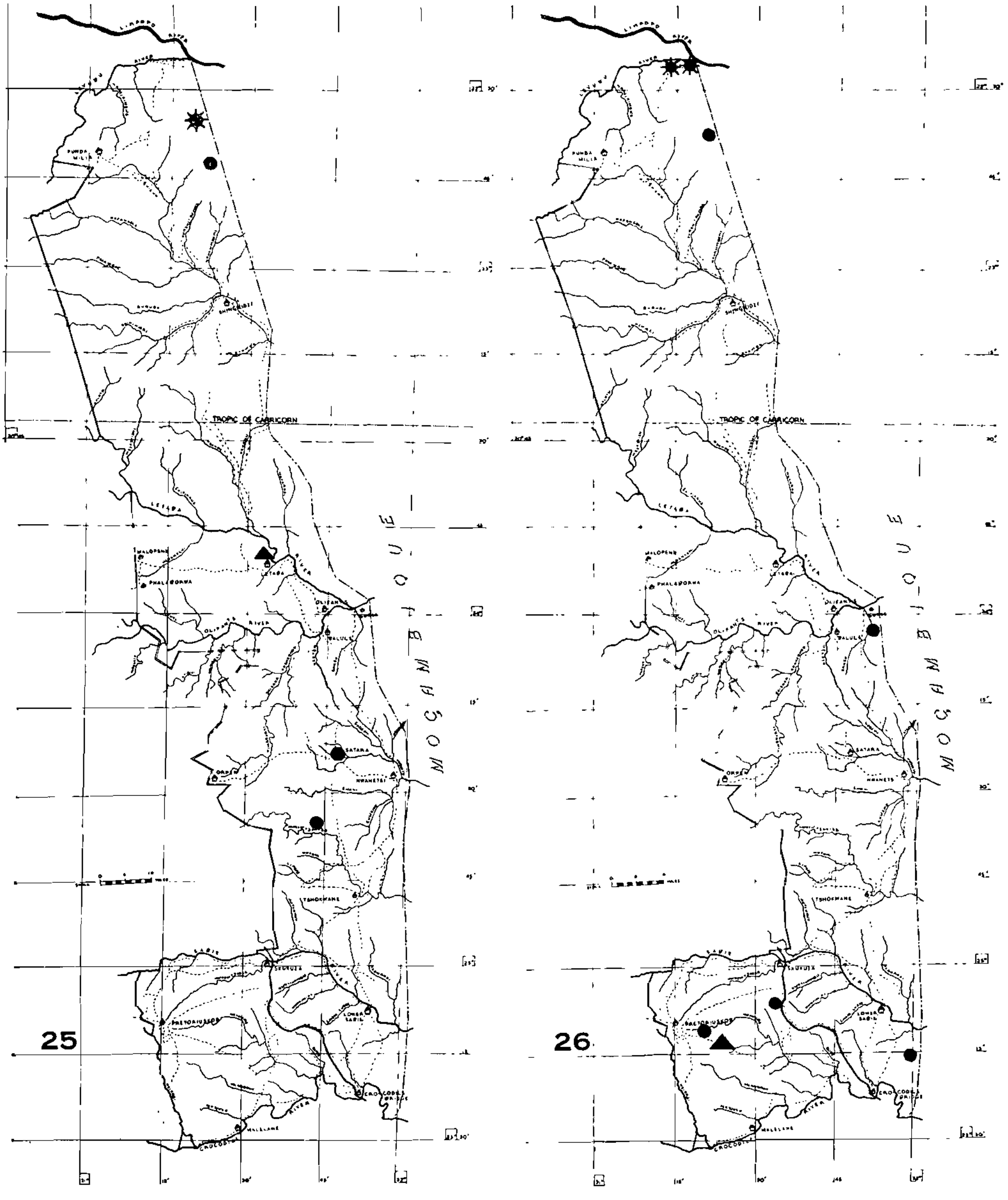
These specimens, collected early in May, 1962, are fully mature, the genitalia (fig. 22) being well developed and considerably swollen. The gonad is of the usual shape and the hermaphrodite duct is spotted, slightly swollen and twisted. The two seminal vesicles are fairly long and pigmented likewise. The albumen gland is large, linguiform and yellow, while the upper parts of the oviduct are closely folded and swollen. The spermatheca issues from the lower part of the oviduct without anterior dilation. The vagina is short and wide. The vas deferens starts from the tip of the penis, being loosely attached to the sheath and the vagina; the prostate is yellowish and fairly small. The penis is enclosed in a muscular sheath, the epiphallus at the apex being separated by a slight constriction; the inside of the penis is lined with folds and papillae as described and figured for *S. striata* Krss. by Quick (1936).

The above description thus indicates that *S. africana* belongs to *Succinea* s.s.

Succinea arboricola Connolly, 1912, figs. 25, 27

Succinea arborea Mousson, *J. Conchyl.* **35**, p. 297, pl. 12, fig. 7, 1887 (type locality: Kalaruri = Kalahari), preoccupied by *Succinea arborea* Adams & Angas, 1863.

Succinea arboricola Connolly, *Ann. S. Afr. Mus.* **11**, p. 220, 1912 (nom. nov.); Connolly, *Ann. S. Afr. Mus.* **33**, p. 446, 1939.



Figs. 25-26. Distribution in the Kruger National Park of 25. *Succinea arboricola* Conn. (star), *S. exarata* Krss. (triangle) and *S. striata* Krss. (dots); 26. *Trachycystis rivularis densestriata* Conn. (dots), *Afropunctum zanguebaricum* (Crvn.) (stars) and *Guppya rumrutiensis* (Prest.) (triangle).

K.N.P.: Mahlakuza Pan area, 'Msimbit' forest, N 28

Four empty shells from block N 28 are somewhat doubtfully identified with *Succinea arborea* Mousson nec Adams & Angas; this species is rather featureless and its position is not quite clear. The shells (fig. 27) are small and as obese as (or even more so than) *S. striata* Krss. The largest specimen in the present sample measures 7·2 × 4·6 mm., l/d 1·56; Mousson's and Connolly's data are 8·8 × 5·4 mm., l/d 1·63 and 9·0 × 5·7 mm., l/d 1·58, respectively. The species is new to the K.N.P.

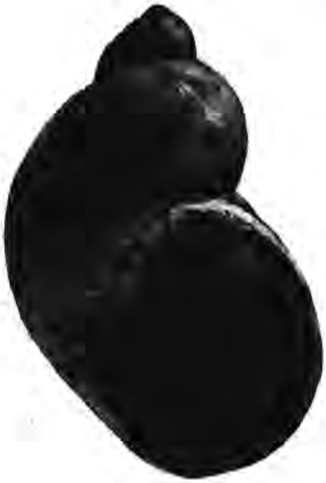


Fig. 27. *Succinea arboricola* Conn., shell from Mahlakuza Pan area, highly enlarged. Photograph Laura Kelsall.

Succinea exarata Krauss, 1848, fig. 25

Succinea exarata Krauss, *Südafr. Moll.*, p. 74, pl. 4, fig. 5, 1848 (type locality: Natal, in swamps); Connolly, *Ann. S. Afr. Mus.* **33**, p. 447, pl. 15, figs. 6-9, 1939.

Succinea delalandei Pfeiffer, *Zeitschr. Malak.* **8**, p. 28, 1851; Haas, *Abh. senckenb. naturf. Ges.* **431**, p. 20, 102, 1936.

This species was not found during the present malacological survey of the K.N.P.; Haas (1936), however, records one specimen from near the Letaba Rest Camp (N 247) and this record is considered sufficiently trustworthy to have been incorporated in fig. 25. On the other hand, it is extremely difficult to identify empty shells in this group and it is thus not impossible that e.g., an aberrant shell of *S. africana* Krss. has been taken to represent *S. exarata*.

Succinea striata Krauss, 1848, fig. 25

Succinea striata Krauss, *Südafr. Moll.*, p. 73, pl. 4, fig. 16, 1848 (type locality: Transvaal, Limpopo River); Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 186, 1925; Germain, *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80**, p. 47, 1935; Haas, *Abh. senckenb. naturf. Ges.* **431**, p. 20, 102, 1936; Connolly, *Ann. S. Afr. Mus.* **33**, p. 441, pl. 15, figs. 3-4, 1939.

K.N.P.: Nwaswitsontso R. bank W. of Kumane Dam, C 112
Near Nwambiya Pan, Nyandu sandveld, N 46

Succinea striata is also mentioned by Haas (1936), viz., from the Satara rest camp (C 71), which record has been incorporated in the map (fig. 25).

Family ENDODONTIDAE

Of the numerous South African representatives of the family Endodontidae so far only two species have been found in the K.N.P. Most endodontids, however, occur further south, only a few species having penetrated the tropical parts of Africa. Another factor which may have been contributory in preventing endodontids invading the Transvaal Lowveld is the low rainfall; most South African species are known from the high rainfall areas on the east coast.

Trachycystis rivularis densestriata Connolly, 1912, fig. 26

Trachycystis rivularis (Krauss) var. *densestriata* Connolly, *Ann. S. Afr. Mus.* **11**, p. 145, fig., 1912 type locality: Zwartkop, Pretoria); Connolly, *Ann. S. Afr. Mus.* **33**, p. 209, pl. 9, figs. 13-14, 1939.

K.N.P.: Skukuza Koppies, S 28
Shithlave Kop, S 36
Godleni, S 74
Bangu, C 12
Mahlakuza Pan area, 'Msimbit' forest, N 28

Trachycystis rivularis densestriata is new to the K.N.P. and appears to be widely distributed throughout the game reserve. The biggest shell was found at Bangu and has a major diameter of 3·4 mm. with 4 whorls. Apparently *T. rivularis densestriata* is the north-eastern subspecies of *T. rivularis* (Krss.); the former was so far only known from the type locality (Zwartkop near Pretoria), Buiskop and Pietersburg. In the K.N.P. it lives in the shelter of leaf litter on the ground, preferably in forest or thick bush.

Afropunctum zanguebaricum (Craven, 1880), fig. 26

Helix zanguebarica Craven, *Proc. zool. Soc. Lond.* 1880, p. 217, pl. 22, figs. 4a-c, 1880 (type locality: Magila, Usambaras, Tanganyika).

Afropunctum zanguebaricum; Adam, *J. Conchyl.* **100**, p. 76, 1960; Verdcourt, *J. Conch.* **25**, p. 158, fig., 1963.

Thapsiella connollyi Preston, *Ann. Mag. nat. Hist.* (8) **9**, p. 70, fig. 3, 1912; Adam, *J. Conchyl.* **100**, p. 76, 1960.

Kaliella connollyi; Connolly, *Ann. S. Afr. Mus.* **33**, p. 165, 1939.

Afropunctum mermodi Haas, *Zool. Anz.* **107**, p. 221, fig. 1, 1934; Verdcourt, *Basteria* **23**, p. 91, 1959.

Thapsia vesti sensu Sparks & Grove, *J. Linn. Soc. Lond. Zool.* **44**, p. 359, pl. 2, figs. k-m, 1961.

K.N.P.: Pafuri picnic spot, N 5
Limpopo-Levubu R. junction, N 6

Afropunctum zanguebaricum is new to South Africa, the Transvaal and the K.N.P. So far it has only been found at the Victoria Falls (type locality of *Thapsiella connollyi* Prest.) and in various localities in East Africa. Verdcourt (1963) has finally cleared up the nomenclatorial puzzle of the various synonyms; *A. zanguebaricum* also occurs in the Quaternary of the Sahara (Sparks & Grove, 1961). The K.N.P. specimens constitute the southernmost record for the species.

All K.N.P. shells were collected from leaf litter under trees; the biggest specimen (from the Limpopo-Levubu junction) has a major diameter of 2·5 mm.

Family LIMACIDAE

There are no indigenous representatives of the Limacidae in Africa; however, a number of species has gained a foothold in South Africa, mainly as a sequel to extensive overseas trade in agricultural products (see e.g., Van Bruggen, 1964c).

Deroceras laeve (Müller, 1774)

Limax laevis Müller, *Verm. terr. fluv. Hist.* **2,** p. 1, 1774 (type locality: Denmark, Fridrichsdal).

Agriolimax laevis; Connolly, *Ann. S. Afr. Mus.* **33,** p. 179, 1939.

Deroceras laeve; Forcart, *Proc. mal. Soc. Lond.* **35,** p. 106, 1963; Van Bruggen, *Beaufortia* **11,** p. 161, 1964.

K.N.P.: Skukuza staff village, S 7

Two juvenile specimens of the imported species *Deroceras laeve* were found on a lawn in the staff village at Skukuza Rest Camp; it is not surprising to find this anthropochorous slug here, because Skukuza is the headquarters of the K.N.P., housing staff members and tourists for whom supplies are brought up by rail to Skukuza Siding. Nevertheless, this European slug is new to the Transvaal and the K.N.P.; further data may be found in Van Bruggen (1964c).

Family EUCONULIDAE

Guppya rumrutiensis (Preston, 1911), figs. 26, 28

Thapsia rumrutiensis Preston, *Ann. Mag. nat. Hist.* (8) **7,** p. 466, pl. 11, fig. 9, 1911 (type locality: "Between Rumruti and Mount Kenia, British East Africa; two specimens were also collected at Rumruti on the Laikipia Plateau.").

Thapsiella opposita Preston, *Proc. zool. Soc. Lond.* 1912, p. 186, pl. 32, fig. 13, 1912 (type locality: Mt. Kenangop, Aberdare Range, Kenya).

Guppya rumrutiensis; Verdcourt, *J. Conchyl.* **100,** pp. 107, 115, 1960.

K.N.P.: Ship Mountain, S 51

Guppya rumrutiensis is widely distributed throughout East Africa (Kenya and Tanganyika, fide Verdcourt, 1960) and is altogether new for the whole Southern African region.

The single specimen, which was kindly identified by Dr. B. Verdcourt, at the same time constitutes the first record of the family Euconulidae south of the Zambezi River.

Very probably the species is widely distributed throughout southeastern Africa, but has escaped attention because of its small size, although it is unlikely to occur in the malacologically better known parts of South Africa, such as Natal, Eastern Cape, etc. *Guppya rumrutiensis* is obviously one of the tropical East African elements in the fauna of Southern Africa, which do not occur south of the Tugela River nor west of the Drakensberg Escarpment.[3]

It is thought advisable to append a concise description of the shell, because it is not featured in Connolly's monograph (1939). The single available shell (fig. 28) is minute, rimate, depressedly turbinate, pale brown and has four whorls, which are rather rapidly increasing; the suture is impressed and the body whorl is slightly angulate at the periphery. The main distinguishing character of the species is the sculpture, which consists of well-marked, equidistant, spiral grooves, which are also present, though less pronounced, on the slightly inflated base of the shell. The aperture is broadly sublunate, the lip is simple and acute, while the columella is short and curved. The present specimen contains a number of juvenile shells; *Guppya rumrutiensis* is known to be ovoviviparous and the uterus may contain "about half a dozen young animals" (Verdcourt, *op. cit.*, p. 108). The shell measures 1·3 × 2·1 mm. (alt. × maj. diam.).

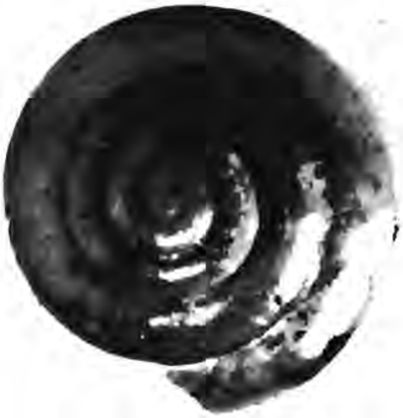


Fig. 28. *Guppya rumrutiensis* (Prest.), shell from Ship Mountain, highly enlarged. Photograph Laura Kelsall.

Family UROCYCLIDAE

The exclusively African pulmonate family Urocyclidae is of great interest because of the various stages of reduction of the shell found throughout this family, ranging from the depressed conoid shells of *Trochonanina* via the reduced shells of *Sheldonia* to the slugs of the genus *Urocyclus*, which only have a small shield-like shell hidden under the mantle. Most urocyclids may be recognized at once by a gland under a little appendage at the end of the foot; this appendage, which may be as long as 6 mm., can be moved sideways quite quickly, reminding one strongly of the wagging tail of a dog. Data on urocyclid slugs have been included in the chapter on slugs.

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[3] The species was recently obtained in N.E. Zululand (*new record*, NM).

Trochonanina mozambicensis (Pfeiffer, 1855), figs. 29, 31

Helix mozambicensis Pfeiffer, *Proc. zool. Soc. Lond.* 1855, p. 91, pl. 31, fig. 9, 1855 (type locality: Tete, Portuguese East Africa).

Ledoulxia mozambicensis; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 131, fig. 7, pl. 8, figs. 1-4, 1925; Germain, *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80**, p. 23, 1935; Connolly, *Ann. S. Afr. Mus.* **33**, p. 157, fig. 17, 1939; Braga, *An. Junta Invest. Ultram.* **7**, 3, p. 120, 1952.

Trochonanina mozambicensis; Zilch, *Handb. Paläozool.* **6** (2), p. 329, fig. 1205, 1959; Verdcourt, *J. Conchyl.* **101**, p. 122, fig. 5, 1961.

K.N.P.: Skukuza Rest Camp, S 7[4]
Numbi Koppie, S 22
Skukuza Koppies, S 28
Cave Skukuza Koppies, S 28
Manung Koppie, S 35
Shabin Koppie, S 35
Sabi R. Poort, S 47
Ship Mountain, S 51
Godleni, S 74
Beacon A, Lebombo Range, S 107
Gorge and surroundings, C 2
Bangu, C 12
Pumbe, C 52
Nwanetsi Koppie, C 62
Between Semane Koppie and Ngirivane Windmill, C 69
Shibotwane, C 72
Near Gudzane Dam, C 73
Timbavati Drift, C 77
Just past Timbavati Drift, C 77
Satara road W. of turn-off, C 84
Majekejekene Windmill, C 88
Sweni firebreak near Mzanene, C 91
Talamati, C 100
Nwaswitsontso R. bank W. of Kumane Dam, C 112
Makonkolweni Spruit, C 115
Nwamuriwa Hill, C 136
Koppie S. of koppie with Orpen plaque, C 148
Sand R. area, C 154

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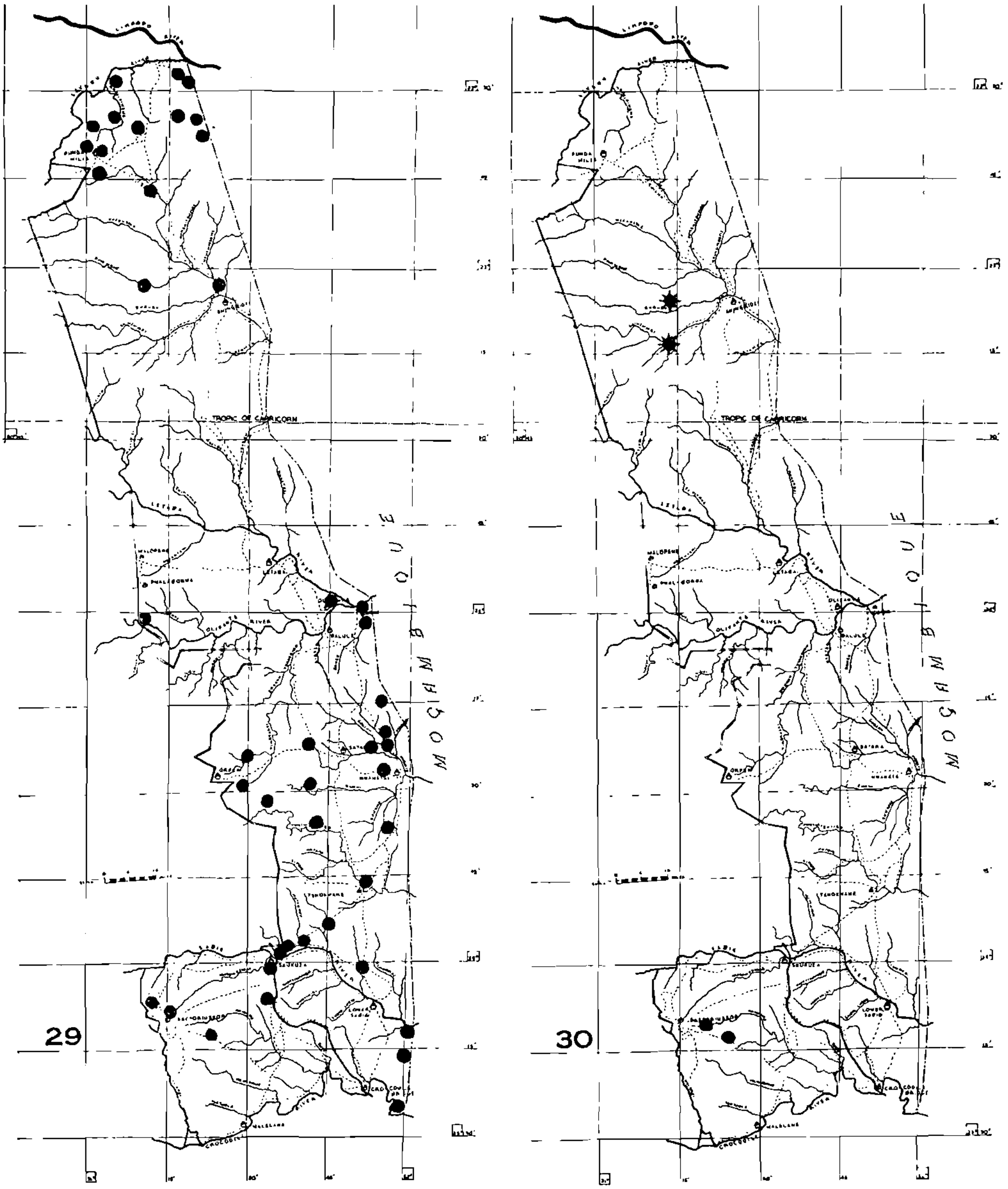
[4] Also obtained here by the Swedish South Africa Expedition (Brinck & Rudebeck) 1950-1951.

Western boundary, Toulon corner, C 154
Sand R. area, C 155
Sabi R. area, C 162
Saliji Road, C 165
Makahandja, Levubu R., N 1
Shaluka, N 5
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Eastern boundary, patch of 'Msimbit' forest, N 6
Eastern boundary, border of sandveld and grey soil, N 13
Eastern boundary, grey soil, N 13
Madzaringwe Spruit, N 16
Shalungwa Spring, N 16
Makangela, N 19
Saselandonga Poort, N 20
Near Klopperfontein Dam, N 25
Shantangalane, N 25
Mahlakuza Pan area, 'Msimbit' forest, N 28
Near Malonga Spring, N 28
Old eastern boundary firebreak near Malonga Spring, N 28
Matukwane Drift, N 30
Near Punda Milia, N 31
W. of Punda Milia along main road, N 40
Dzundwini Hill, N 50
Near Phugwane R., N 103
Along Shingwedzi R., W. of camp, N 107
Olifants Rest Camp, N 272
Mahulule Koppies, N 273

Trochonanina mozambicensis is one of the characteristic species distributed throughout the K.N.P. (fig. 29); it has also been recorded from Barberton and the Zoutpansberg. Outside the Transvaal its range extends from southern Portuguese East Africa through Rhodesia into East Africa and the Congo; the southernmost locality is in Swaziland (Ranches Ltd., leg. A. G. White, June 1937, Transvaal Museum, Natal Museum (No. 3955): *new record*), which at the same time is also the southernmost limit of the genus. It is clearly one of the East African elements in the fauna of Southern Africa. Several allied species occur east of the Lebombo Range, but *Trochonanina mozambicensis* can always be recognized by the fairly coarse sculpture of the shell. The spiral sculpture of the apex is also diagnostic, but this and the depression of the spire are not always completely reliable characters. The shell of *T. mozambicensis* may be as high as that of *T. elatior* (Mts.) and the apical sculpture may be partly or wholly worn away or even somewhat poorly developed. However, the general sculpture of the shell of *T. elatior* (Mts.) consists of very fine oblique costulae; by comparison shells of *T. mozambicensis* have a very coarse sculpture, although basically of the same nature. Authenticated specimens are essential for comparison. The author had at his disposal the following material identified and recorded by Connolly (1925, 1939):



Figs. 29-30. Distribution in the Kruger National Park of 29. *Trochonanina mozambicensis* (Pfr.) and 30. *T. thermarum* (M. & P.) (stars) and *Sheldonia poeppigi* (Pfr.) (dots).

T. mozambicensis—Lebombo Mountains (NM 3464); Magude District, Nuanetsi River (NM 3636);

T. elatior—Mtisherra River Valley (NM 3343, 3344, 3345).

Although showing a good deal of variation, it appears that all K.N.P. material belongs to *T. mozambicensis* as interpreted by Connolly after his comparison with Pfeiffer's types. Dissection showed minor differences, but served to confirm the above findings. Advice and help in this difficult problem has been freely given by Dr. B. Verdcourt, to whom grateful acknowledgements are due.

The largest available shell measured 10·7 × 18·5 mm. (Numbi Koppie) and consequently compares favourably with the measurements of East African specimens (see e.g., Von Martens, 1897). Two very small juveniles with a diameter of 3·6 mm. were collected at the western boundary (Toulon corner, C 154) on 29th February, 1964; very probably the eggs are laid in December-January. Among material from Beacon A there is a curious abnormal shell, in which the last 1¼ whorls are not keeled but gently rounded; keels of earlier whorls are plainly visible and the shell is otherwise quite normal.

The animal is yellowish with a caudal mucous pore overhung by a conspicuous pointed caudal process. The jaw of a specimen from block C 155 with a span of 1·2 mm. has been figured in fig. 31; the radula agrees with fig. 17 of Connolly (1939, p. 158).

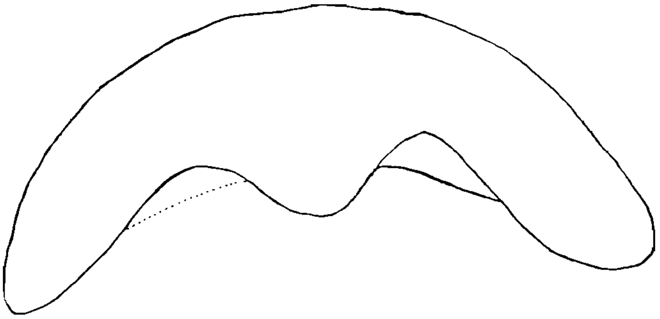


Fig. 31. *Trochonanina mozambicensis* (Pfr.) from Sand River area, jaw, actual span 1·2 mm., highly enlarged.

In the K.N.P. *Trochonanina mozambicensis* is partial to stones and logs, hiding in cracks and caves and only rarely under the bark of trees; Pilsbry (1919) records it from under the leaf sheaths of wild bananas in the Congo. The wide range suggests a certain amount of indifference towards ecological conditions.

It is one of the first species of molluscs to be collected in the K.N.P.; specimens from the "Sabi Game Reserve" (Connolly, 1939) collected by Dr. E. L. Gill in 1927 are still preserved in the South African Museum (Cape Town, No. A 7228, 22 shells). Other early specimens were collected by Col. J. Stevenson-Hamilton "near Punda Maria under bark knoppiesdoring" (XI.1940, Transvaal Museum, Natal Museum No. 3956).

Trochonanina (Zingis) thermarum (Melvill & Ponsonby, 1909), fig. 30

Zingis thermarum Melvill & Ponsonby, *Ann. Mag. nat. Hist.* (8) **4**, p. 491, pl. 8, fig. 14, 1909 (type locality: Warmbaths, Transvaal); Connolly, *Ann. S. Afr. Mus.* **33**, p. 155, 1939.

K.N.P.: Ponda Hills, N 115
Tsange Koppie, N 136

Trochonanina thermarum is only represented in the K.N.P. collection by three weathered shells from the Ponda Hills and Tsange Koppie, the largest of which has a major diameter of 15 mm. The species is known to occur in the Transvaal (Potgietersrus, Warmbaths) and Southern Rhodesia (Musami, Umtali, Umvuma); it is new to the K.N.P.

The systematic status of the species must perforce remain uncertain as long as the anatomy is unknown. The sculpture of the apex of the shell is close to that of *T. mozambicensis* (Pfr.); for the time being the species under discussion is best referred to the genus *Trochonanina* Mousson, 1869.

Sheldonia (*Kerkophorus*) *poeppigi* (Pfeiffer, 1846), fig. 30

Vitrina poeppigii Pfeiffer, *Symb. Hist. Helic.* **3**, p. 81, 1846 (type locality: Port Natal = Durban).
Sheldonia (*Kerkophorus*) *poeppigii;* Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 126, 1925; Connolly, *Ann. S. Afr. Mus.* **33**, p. 134, 1939.

K.N.P.: Shithlave Kop, S 36
Ship Mountain, S 51

Sheldonia poeppigi is the only species of *Sheldonia* so far found in the K.N.P., although according to Connolly (1939) at least six more are known to occur in the Transvaal. *S. poeppigi* is widely distributed along Southern Africa's east coast, but does not occur far inland, nor south of Port St. Johns. It obviously survives only where there is a fair amount of rainfall and thick bush or forest, as is well illustrated by the two known localities in the K.N.P. At both localities banded and unbanded shells have been found; the largest specimens have a major diameter of 13·6 mm. (Ship Mountain) and 13·7 mm. (Shithlave Kop) respectively.

S. poeppigi is new to the K.N.P.

Gudeëlla pinguis (Krauss, 1848), fig. 32

Helix pinguis Krauss, *Südafr. Moll.* p. 75, pl. 4, fig. 19, 1848 (type locality: Natal).
Gudeëlla pinguis; Connolly, *Trans. R. Soc. Afr.* **12**, p. 127, 1925; Connolly, *Ann. S. Afr. Mus.* **33**, p. 151, fig. 15, pl. 2, figs. 12-15, 1939.

K.N.P.: Manung Koppie, S 35
Shabin Koppie, S 35
Crocodile R. bank between Mbyamiti and Bume mouths, S 83
Bangu, C 12
Near Orpen Dam, C 136
Sand R. area, C 155
Sabi R. area, C 162
Mahlakuza Pan area, 'Msimbit' forest, N 28
Near Malonga Spring, N 28
Shipudze Ridge, N 38

Along Shingwedzi R., W. of camp, N 107
Olifants Rest Camp, N 272

Gudeëlla pinguis, new to the K.N.P., extends from Natal to Kenya and the Congo; in Southern Africa it does not range far inland, the westernmost known localities being Sibasa in the Transvaal and the Matopos in Southern Rhodesia (*new record*, NM). *G. pinguis* is thus another example of East African species in Southern Africa.

The species occurs throughout the national park (fig. 32) in thick bush and gallery forest, and is particularly common in the 'Msimbit' (Lebombo Ironwood, *Androstachys johnsonii* Prain, fam. Euphorbiaceae) forest in the northeastern districts of the game reserve.

The shells of the various populations differ in size and shape, but never quite reach the dimensions of Natal specimens (among which Krauss's type, fide Connolly, 1939). Some adult shells have the following measurements:

Manung Koppie	3·6 × 6·4 mm.
Bangu	3·8 × 6·2 mm.
Near Orpen Dam	4·5 × 7·1 mm.
Mahlakuza Pan area	4·2 × 7·0 mm.
	4·4 × 6·7 mm.
	4·1 × 6·6 mm.
Holotype ex Connolly	4·2 × 7·6 mm.

Zilch (1959-1960) synonymises *Gudeëlla* with the genus *Thapsia* Albers, 1860, but apparently is not too happy about this move. The present author prefers to retain *Gudeëlla* until more anatomical data become available.

Family FERUSSACIIDAE

Cecilioides gokweanus (Boettger, 1870), fig. 33

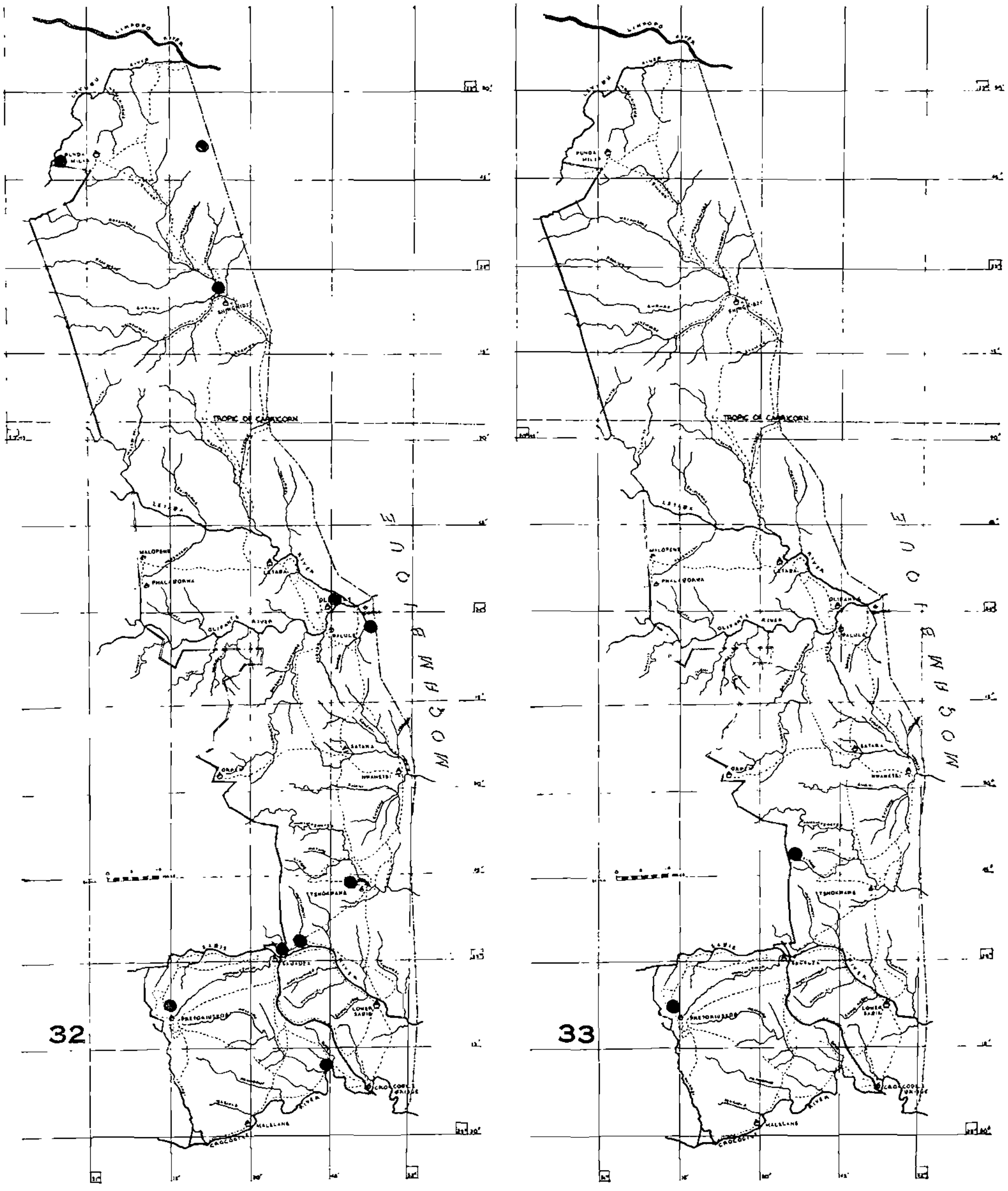
Cionella gokweana Boettger, *Ber. Offenb. Ver. Naturk.* **11**, p. 47, pl. 1, fig. 2, 1870 (type locality: Gokwe River, Bechuanaland).
Cecilioides gokweanus; Connolly, *Ann. S. Afr. Mus.* **33**, p. 370, pl. 8, figs. 14-17, 1939

K.N.P.: Shabin Koppie, S 35
Near Hlangulene, C 125

Cecilioides gokweanus belongs to a group of blind snails which lead a subterranean life. The specimen from near Hlangulene was collected alive under a log. The one from Shabin Koppie is 3·7 mm. long; the spirits specimen from near Hlangulene is too badly damaged for measurements to be taken. Connolly (1939) records the species from two localities only in Bechuanaland and the Transvaal respectively, although he hints at a possibly wider distribution into East Africa. *C. gokweanus* is new to the K.N.P.

Family SUBULINIDAE

The Subulinidae are closely allied to the Achatinidae and have indeed only comparatively recently been recognized as a separate group. The family Subulinidae is very



Figs. 32-33. Distribution in the Kruger National Park of 32. *Gudeëlla pinguis* (Krss.) and 33. *Cecilioides gokweanus* (Bttg.).

well represented in Southern Africa, and the K.N.P. has its fair share of species; in the present paper only seven have been discussed, while some doubtful species, particularly in the genus *Curvella*, are still under investigation. Subulinids can usually be found (frequently in abundance) in sheltered localities, such as under logs, rocks and stones, in rotting vegetation, leaf litter and the like. It is always advisable to note the colour of the animal before preservation, because this may be diagnostic (see e.g., sub *Subulina mamillata* (Crvn.), *S. gracillima* Conn. and *Opeas lineare* (Krss.)).

Subulina gracillima Connolly, 1919, figs. 34, 36-37

Subulina gracillima Connolly, *Rec. Albany Mus.* **3**, p. 216, fig., 1919 (type locality: S. Rhodesia, Victoria Falls); Connolly, *Ann. S. Afr. Mus.* **33**, p. 334, 1939.

K.N.P.: Shipandane Drift, Tsende R., N 187

Among the many hundreds of Subulinidae from the K.N.P. there is only one sample of *Subulina gracillima*. These specimens were compared with Rump's Natal Museum material from Gatooma and found to agree well; the largest shell measures 11·7 × 2·8 mm. The body is dark brown, which distinguishes the present species immediately from *S. mamillata* (Crvn.), which has a dark grey or black body.

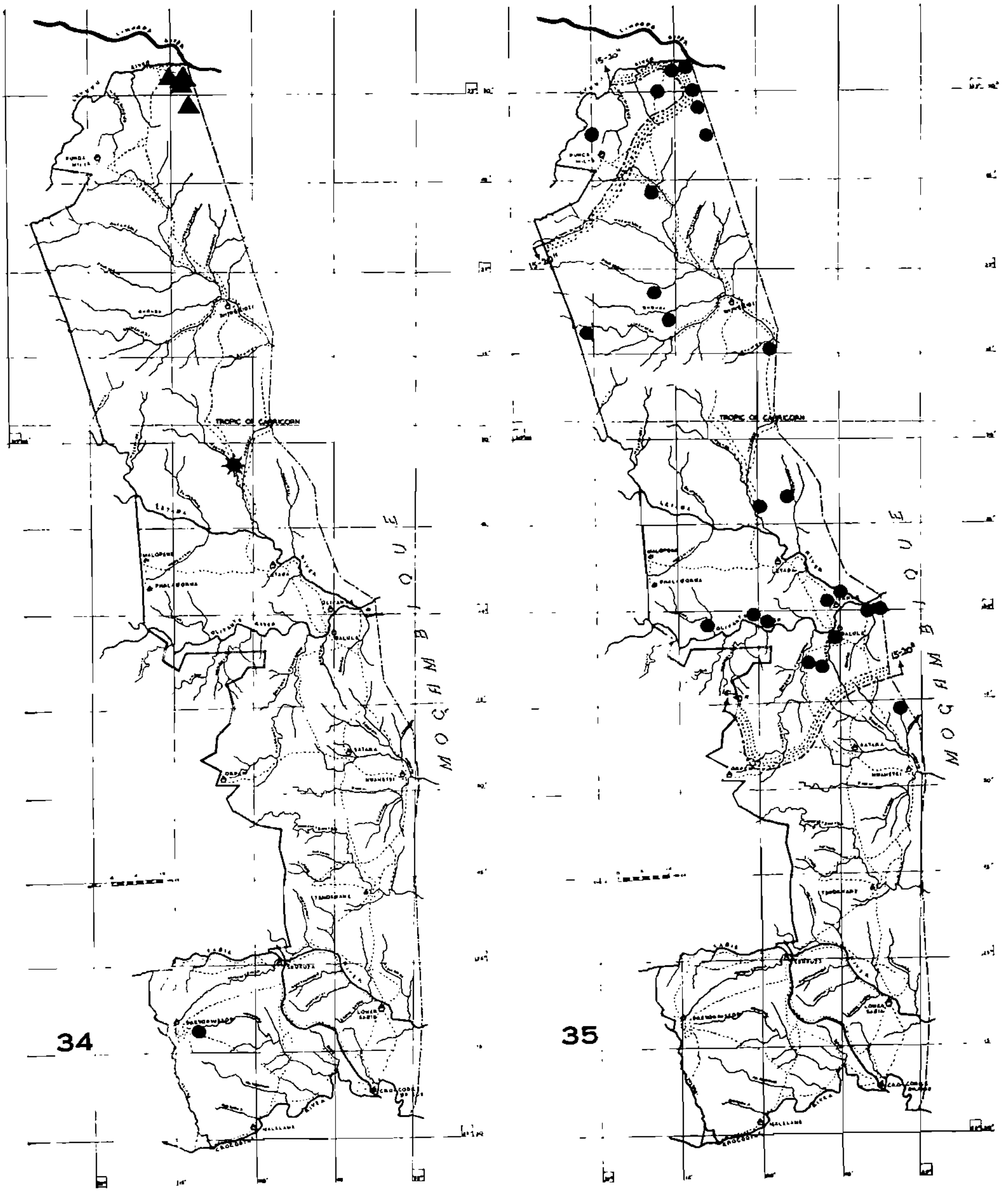
Radula elements taken from a specimen with a shell of 9·5 mm. are figured in fig. 37. The radula measures 1·2 × 0·4 mm. and has about 86 transverse rows; the formula is 28—1—28. The jaw (fig. 36) is of the usual type in the genus *Subulina* and has a span of 0·6 mm. The species is evidently closely allied to both *S. mamillata* (Crvn.) and *S. octona* (Brug.).

So far *S. gracillima* has only been recorded from Southern Rhodesia; the species is thus new for South Africa, the Transvaal and the K.N.P.

Subulina mamillata (Craven, 1880), figs. 35, 38-39

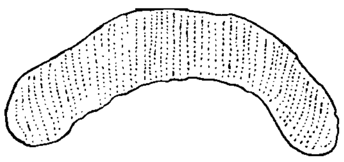
Achatina mamillata Craven, *Proc. zool. Soc. Lond.* 1880, p. 215, pl. 22, fig. 8, 1880 (type locality: Madagascar, Nossi Bé).
Subulina mamillata; Connolly, *Ann. S. Afr. Mus.* **33**, p. 333, 1939.

K.N.P.: Gorge and surroundings, C 2
Olifants R. Poort area, C 3
Along main road just S. of Olifants R., C 24
Past junction Timbavati and Shisakashangondzo R., C 30
W. of Ngotsa Dam, C 31
Pumbe, C 52
Hape Koppie, N 5
Shaluka, N 5
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Near Thambyi Spruit, Pafuri main road, N 11
Eastern boundary, grey soil, N 13
Saselandonga Poort, N 20



Figs. 34-35. Distribution in the Kruger National Park of 34. *Subulina gracillima* Conn. (star), *Xerocerastus burchelli* (Gray) (triangles) and *Euonyma varia* Conn. (dot); 35. *Subulina mamillata* (Crvn.), the zone with a mean annual rainfall of 15-20 inches has been delimited by dotted lines.

Road to Shidzivane Lookout, N 22
Eastern boundary, Mahlakuza Pan area, 'Msimbit' forest, N 28
Old eastern boundary firebreak near Malonga Spring, N 28
Dzundweni Hill, N 50
Near Phugwane R., N 103
Ponda Hills, N 115
Shangoni Koppies, N 122
Eastern boundary just N. of Shingwedzi R., N 141
Along Manyeleti past Ambandwini, N 209
Tsende plots, N 216
N. of Olifants Camp after second Mangwanduna junction, N 260
NW. of Olifants Camp, N 260
N. of Olifants Camp, N 272
Olifants firebreak, N 276
Olifants R. 2 miles E. of Manyukelani mouth, N 278
S. of Manyukelani, N 278
Junction Olifants and Mbulweni firebreaks, N 279



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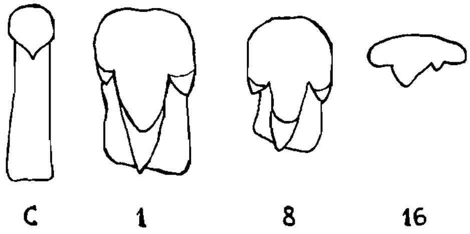

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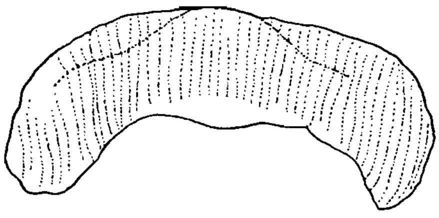

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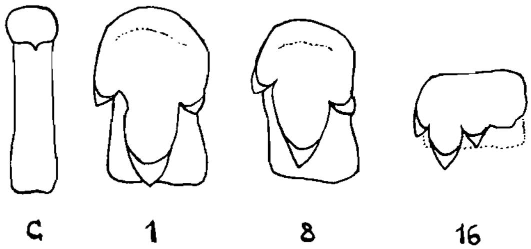

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Figs. 36-39.—36-37. *Subulina gracillima* Conn. from Shipandane Drift, 36. Jaw, actual span 0·6 mm.; 37. Radula elements; 38-39. *S. mamillata* (Crvn.) from road to Shidzivane Lookout, 38. Jaw, actual span 1 mm.; 39. Radula elements. All figures highly enlarged.

Subulina mamillata appears to be one of the commonest subulinids in certain areas of the K.N.P. It varies a good deal, mainly in the shape and size of the shell. At first, some doubt as to the identity of this species was entertained, but comparison with specimens in the Natal Museum identified by Connolly combined with the opinion of Dr. B. Verdcourt removed all doubt. Radulae taken from specimens from various populations throughout the game reserve proved identical, which also has contributed to the present author considering all large *Subulina* with a dark grey or black body in the K.N.P. to belong to *S. mamillata*. The jaw (fig. 38) has a span of about 1 mm. and is of the usual subulinid type. The radula measures 2 × 1 mm. and has the following number of transverse rows and formula: about 92 rows, 29—1—29 (Pumbe); about 108 rows, 27—1—27 (Shidzivane Lookout); about 110 rows, 28—1—28 (Shaluka). Selected radula elements are figured in fig. 39. Apparently the radula differs somewhat from that of *S. octona* (Brug.) (cf. description and figures by e.g., Pilsbry, 1946, p. 173), which in addition to the shell characters proves that *S. mamillata* is definitely not a synonym of the former.

The variation in size and shape is clearly demonstrated by the following table of measurements:

Hape Koppie	16·6 × 4·1 mm., l/d 4·05
Shaluka	19·2 × 4·3 mm., l/d 4·46
	19·2 × 4·2 mm., l/d 4·57
	19·0 × 4·5 mm., l/d 4·22
	18·3 × 4·1 mm., l/d 4·46
	18·2 × 4·2 mm., l/d 4·33
	17·0 × 4·1 mm., l/d 4·15
	16·5 × 4·1 mm., l/d 4·02
S. of W.N.L.A. quarters	17·7 × 4·3 mm., l/d 4·11
	17·5 × 4·2 mm., l/d 4·17
Near Thambyi Spruit	16·4 × 4·0 mm., l/d 4·10
	16·3 × 4·2 mm., l/d 3·88
	15·8 × 4·1 mm., l/d 3·85
	15·1 × 3·8 mm., l/d 3·97
Saselandonga Poort	16·8 × 4·0 mm., l/d 4·20
Near Phugwane R.	16·6 × 3·8 mm., l/d 4·37
	14·2 × 3·8 mm., l/d 3·74
Ponda Hills	18·0 × 4·2 mm., l/d 4·29
Along Manyeleti	18·3 × 4·2 mm., l/d 4·36
	16·1 × 4·1 mm., l/d 3·93
	15·7 × 4·3 mm., l/d 3·65
NW. of Olifants Camp	15·5 × 4·2 mm., l/d 3·69
	15·2 × 4·2 mm., l/d 3·62

These measurements may be summarized as follows: 14·2—19·2 × 3·8—4·5 mm., l/d 3·62—4·57 (23 specimens).

It appears that in the K.N.P. *Subulina mamillata* occurs mainly in the low rainfall area (fig. 35); the present records constitute the southernmost for the species which is new to South Africa, the Transvaal and the K.N.P. The species appears to be widely spread

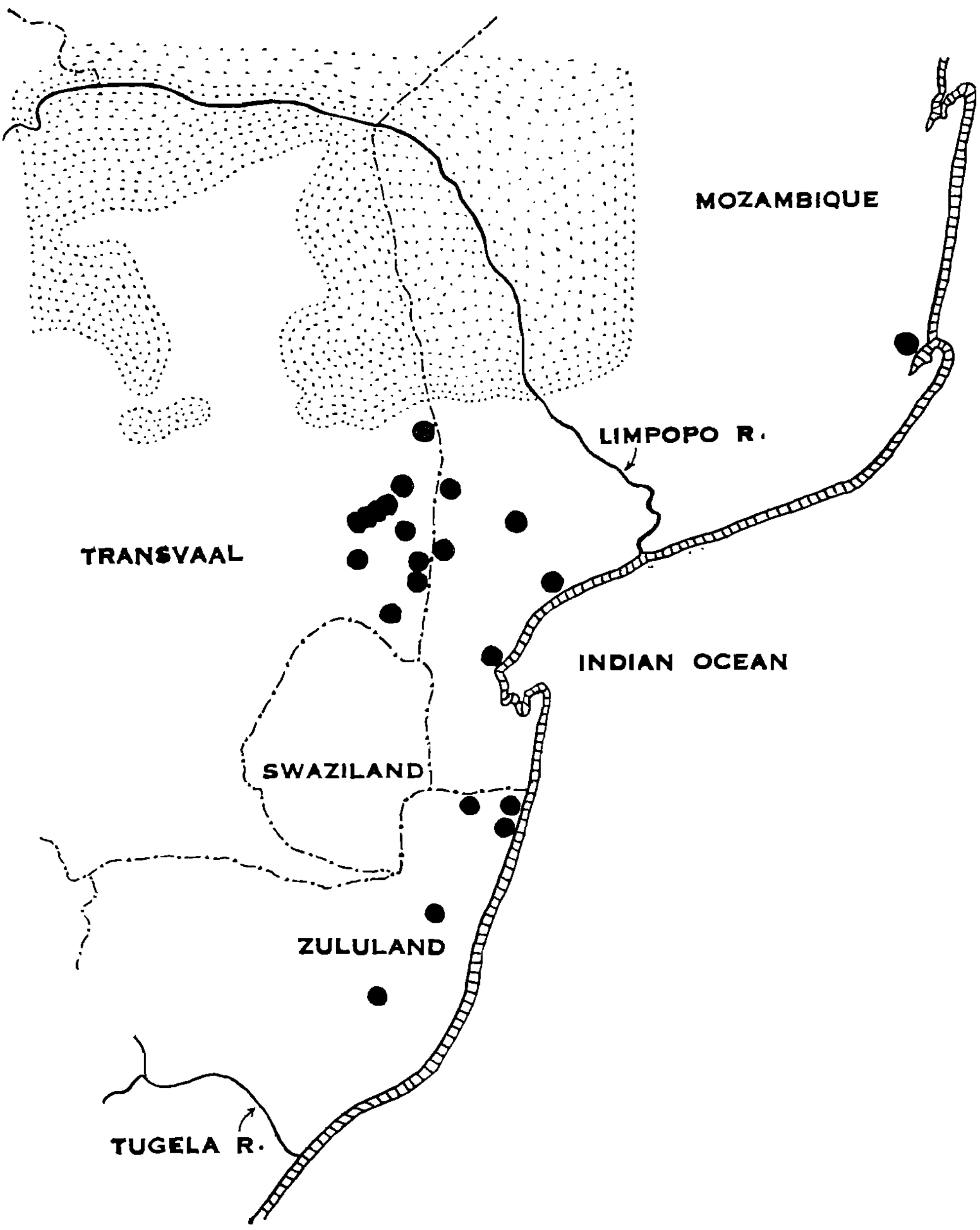


Fig. 40. General distribution in Southern Africa of *Pseudoglessula boivini* (Mor.), the shaded area depicts the zone with 15-20 inches mean annual rainfall.

throughout Central and East Africa and thus represents one of the tropical African elements in the fauna of the Transvaal.

Pseudoglessula (Kempioconcha) boivini (Morelet, 1860), figs. 40-41

Glandina boivini Morelet, *Sér. Conchol.* **2**, p. 72, pl. 5, fig. 5, 1860 (type locality: Kenya, Mombasa). *Pseudoglessula boivini;* Connolly, *Trans. R. Soc. Afr.* **12**, p. 171, pl. 6, figs. 1-4, 1925; Germain, *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80**, p. 43, 1935; Connolly, *Ann. S. Afr. Mus.* **33**, p. 329, fig. 27, 1939. *Pseudoglessula zulu* Haas, *Abh. senckenb. naturf. Ges.* **431**, p. 14, pl. 1, fig. 9, 1936.

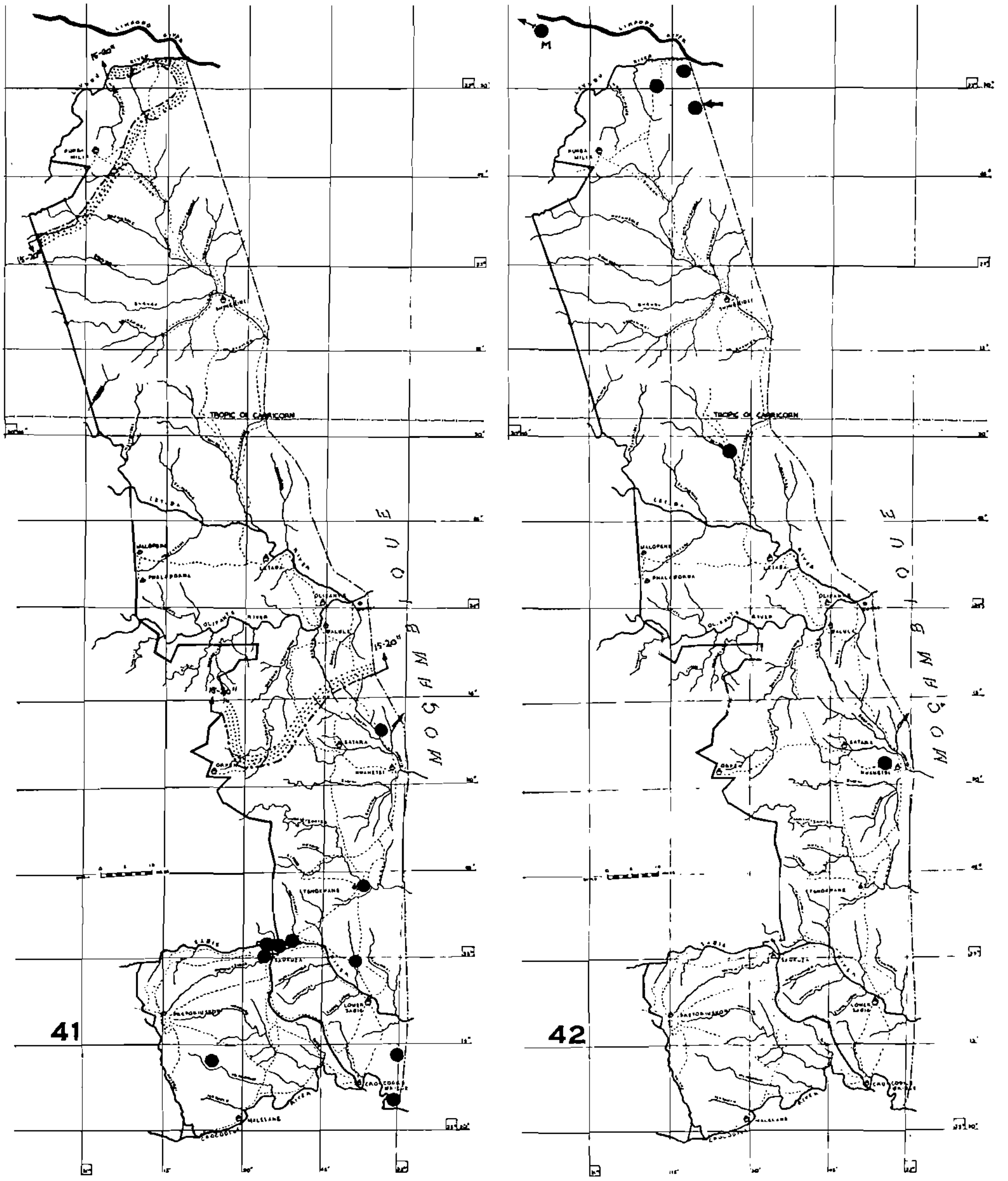
K.N.P.: Skukuza Rest Camp, S 7
Godleni, S 74
Mlambane Drift, S 77
Beacon A, Lebombo Range, S 107
Nwanetsi Koppie, C 62
Near Orpen Dam, C 136
Western boundary, Toulon corner, C 154
Sand R. area, C 154
Sand R. area, C 155
Sabi R. area, C 162
Saliji Road, C 165

Pseudoglessula boivini is another of the East African faunal elements in Southern Africa, occurring from Kenya southward in the coastal plains as far as Zululand, being unknown beyond the Tugela River; it does not venture far westward, the westernmost records in Southern Africa being those in the K.N.P. It is the only species of *Pseudoglessula* to penetrate south of the Limpopo and is new to both the Transvaal and the K.N.P. All records are from the area which has a mean annual rainfall of over 20", which also holds good for the known records outside the game reserve in Zululand and Mozambique (fig. 40). The species does not occur in the higher rainfall area in the Northern Transvaal, which includes the northwestern districts of the K.N.P.

P. boivini and *P. kirki* (Dohrn) are generally difficult to distinguish. Although the latter does not occur south of the Limpopo, it seems advisable to check all specimens of *Pseudoglessula* carefully. Unfortunately Connolly (1939) does not make the differences between these two closely allied species quite clear. In the present author's opinion *P. kirki* (Dohrn) grows much larger than the 26 mm. recorded by Connolly; specimens in the Natal Museum from Chiluvo, Mozambique, measure up to 30 mm., a size which is never reached by *P. boivini* (record specimen 25·8 mm., K.N.P., Beacon A). While the relation length/maximum diameter is usually not much different in both species, the last whorl is proportionally larger in *P. kirki* (Dohrn); also the peristome has a tendency to become somewhat expanded, a phenomenon which does not seem to occur in *P. boivini.* The difference in length of the body whorl may be demonstrated by the following table:

P. kirki

length shell/length last whorl
29·5/17·0 mm. = 1·73, Chiluvo (NM)
29·0/17·8 mm. = 1·63, Chiluvo (NM)
26·0/16·2 mm. = 1·60, Connolly, 1939
24·0/14·5 mm. = 1·65, Mtisherra R. Valley (NM)



Figs. 41-42. Distribution in the Kruger National Park of 41. *Pseudoglessulaboivini* (Mor.), the zone with a mean annual rainfall of 15-20 inches has been delimited by dotted lines, and 42. *P. hamiltoni* nov. spec., the heavy arrow indicating the type locality, while the one locality outside the Kruger National Park has been indicated in the top left corner.

P. boivini
length shell/length last whorl
25·8/14·0 mm. = 1·85, Beacon A, K.N.P.
25·0/13·5 mm. = 1·85, Beacon A, K.N.P.
21·5/12·0 mm. = 1·79, Elscheleselwanhla[5] (NM)
20·5/12·4 mm. = 1·65, Connolly, 1939

All measured specimens are in the collections of the Natal Museum, except the ones from which Connolly took his measurements.

The population of Beacon A has unusually large shells:

25·8 × 10·9 mm.
25·6 × 11·6 mm.
25·6 × 11·3 mm.
25·5 × 10·8 mm.
25·2 × 10·6 mm.
25·0 × 10·9 mm.
25·0 × 10·8 mm.
24·9 × 11·0 mm.

None of these shells, however, has more than the normal seven whorls.

Average specimens from various localities have the following measurements:

Godleni	22·0 × 10·4 mm.
Sand R. area, C 155	21·3 × 10·1 mm.
do., C 154	20·8 × 10·5 mm.
Godleni	19·2 × 9·0 mm.

Pseudoglessula (Kempioconcha) hamiltoni n.sp., figs. 42-45

A small and slender species (up to 17·8 mm. long) of *Pseudoglessula*, subgenus *Kempioconcha*, with 10-11 whorls.

Shell (fig. 45) small, slender, turriform, rimate, uniform pale corneous brown, sides practically straight, apex mamillate. Whorls 10-11, regularly increasing, not very convex, smoothly rounded at periphery in fully mature examples, but very slightly angulate in juvenile shells. Whorls sculptured with numerous well-marked, close, regular, straight, slightly oblique costae, which are as far apart as they are wide; first half whorl smooth, after which the costae (at first rather faint) are rather widely spaced, to become denser in the next whorl. Suture well defined, somewhat impressed. Aperture subovate, labrum sharp, slightly receding in profile, columella whitish, straight in adult shells, somewhat concave in juveniles, blending evenly into basal margin of shell, margin of columella narrowly reflected over narrow umbilicus.

Animal yellowish. The radula of paratype 19 was extracted and examined; it measures 1·9 × 0·8 mm. and has about 79 transverse rows; the formula is 25—1—25. Selected elements are figured in fig. 43; the teeth are of the usual type in the genus *Pseudoglessula*. The jaw (fig. 44) has a span of 0·6 mm.

Measurements holotype shell, length 16·2 mm.,
major diameter 4·8 mm., l/d 3·37,
aperture length 3·9 mm.,
aperture width, 2·8 mm.,
length last whorl 6·3 mm., 10¼ whorls.

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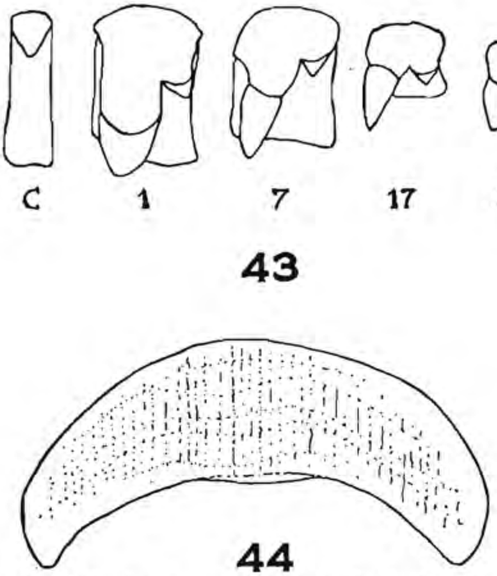
[5] This locality is situated in N. Zululand on the road to Lake Sibayi.



Figs. 43-44. *Pseudoglessula hamiltoni* nov. spec., paratype 19, 43. Radula elements; 44. Jaw, actual span 0·6 mm. All figures highly enlarged.

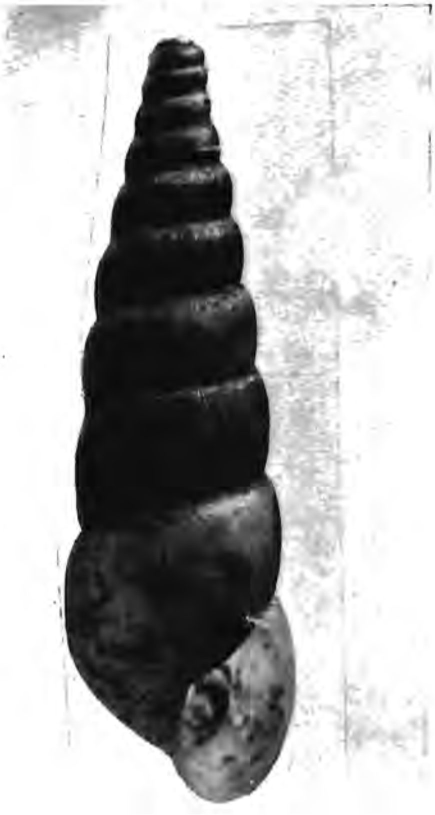


Fig. 45. *Pseudoglessula hamiltoni* nov. spec., holotype, highly enlarged. Photograph Laura Kelsall.

A total of thirty shells of the type series have been measured, which measurements are tabulated below:

deposited in museum	*type*	*loc.*	*length*	*max. diam.*	*l/d*
Pietermaritzburg	paratype 1	N 6	17·8	5·5 mm.	3·24
Tervuren	paratype 2	N 11	17·7	5·1 mm.	3·47
K.N.P.	paratype 3	N 11	17·1	4·9 mm.	3·49
Cambridge	paratype 4	N 11	17·0	5·3 mm.	3·21
London	paratype 5	N 11	16·7	5·2 mm.	3·21
Brussels	paratype 6	N 187	16·5	5·1 mm.	3·23
Leiden	paratype 7	N 11	16·5	5·0 mm.	3·30
K.N.P.	paratype 8	N 6	16·3	5·3 mm.	3·07
Cape Town	paratype 9*	C 84	16·3	5·2 mm.	3·11
Pietermaritzburg	holotype	N 20	16·2	4·8 mm.	3·37
Cambridge	paratype 10	N 187	16·1	5·1 mm.	3·16
Paris	paratype 11	N 6	15·9	4·9 mm.	3·24
Frankfurt	paratype 12	N 11	15·8	5·1 mm.	3·10
Tervuren	paratype 13	N 11	15·7	4·7 mm.	3·34
Cape Town	paratype 14	N 11	15·6	4·9 mm.	3·19
Leiden	paratype 15	N 11	15·6	4·9 mm.	3·19
K.N.P.	paratype 16	N 11	15·5	5·1 mm.	3·04
Brussels	paratype 17	N 20	15·5	4·9 mm.	3·16
Cambridge	paratype 18	N 11	15·3	4·8 mm.	3·19
Pietermaritzburg	paratype 19*	C 84	15·1	4·8 mm.	3·14
Pietermaritzburg	paratype 20*	C 84	15·0	4·9 mm.	3·06
London	paratype 21	N 11	14·9	4·7 mm.	3·17
Frankfurt	paratype 22	N 11	14·8	4·9 mm.	3·02
Brussels	paratype 23	N 11	14·7	4·7 mm.	3·13
Paris	paratype 24	N 11	14·6	4·7 mm.	3·11
London	paratype 25	C 84	14·5	4·9 mm.	2·96
Tervuren	paratype 26	N 187	13·6	4·7 mm.	2·89
Pietermaritzburg	paratype 27*	N 11	13·6	4·7 mm.	2·89
Leiden	paratype 28	N 187	13·5	4·9 mm.	2·75
Cape Town	paratype 29	N 187	13·5	4·8 mm.	2·81

In the above table alcohol specimens have been indicated by an *.

Holotype from South Africa, Transvaal, K.N.P., Saselandonga Poort, 'Msimbit' forest and sandveld on eastern boundary, block N 20, 24.XI.1963, leg. Biologist K.N.P., in collection Natal Museum, Moll. No. 4202, Type No. 1106.

Paratypes in Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium (nos. 6, 17, 23), Museum of Comparative Zoology, Cambridge, Mass., U.S.A. (nos. 4, 10, 18), South African Museum, Cape Town (nos. 9, 14, 29), Forschungs-Institut Senckenberg, Frankfurt-on-Main, Germany (nos. 12, 22), Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands (nos. 7, 15, 28), British Museum (Natural History), London, England (nos. 5, 21, 25), Laboratoire de Malacologie, Muséum National d'Histoire Naturelle, Paris, France (nos. 11, 24), Natal Museum, Pietermaritzburg (nos. 1, 19, 20, 27), K.N.P. collection, Skukuza, Transvaal (nos. 3, 8, 16), and Musée Royal de l'Afrique Centrale, Tervuren, Belgium (nos. 2, 13, 26).

Furthermore two unmeasured paratypes have been deposited in each of the following museums: Brussels, Cape Town, Cambridge, Frankfurt, Leiden, London, Paris and Tervuren. The remaining type specimens have been divided between the Natal Museum and the K.N.P. collection.

The following type material has been studied (distribution shown on map fig. 42):

Kruger National Park, C 84, Satara road west of turn-off, 21.II.1964, leg. A. C. van Bruggen c.s. (among which paratypes 9, 19, 20, 25); N 6, eastern boundary, 3 miles from Pafuri, 9.IX.1963, leg. Biologist; N 6, eastern boundary, high 'Msimbit' forest south of W.N.L.A. quarters, 26.II.1964, leg. A. C. van Bruggen c.s. (among which paratypes 1, 8, 11); N 11, near Thambyi Spruit, Pafuri main road, 4.V.1962, leg. A. C. van Bruggen c.s.; do., 26.II.1964, leg. A. C. van Bruggen c.s. (among which paratypes 2, 3, 4, 5, 7, 12, 13, 14, 15, 16, 18, 21, 22, 23, 24, 27 and additional material in Frankfurt, Leiden, London, Paris and Tervuren); N 20, Saselandonga Poort, 'Msimbit' forest and sandveld on eastern boundary, 24.XI.1963, leg. Biologist K.N.P. (*type locality*, holotype and paratype 17); N 187, Shipandane Drift, Tsende River, 24.II.1964, leg. A. C. van Bruggen c.s. (among which paratypes 6, 10, 26, 28, 29 and additional material in Brussels, Cambridge U.S.A. and Cape Town).

Paratype 30 is from outside the K.N.P.; it was collected many years ago on the banks of the Limpopo River near Messina Mine by W. Anderson (Burnup collection in Natal Museum). This particular specimen, although in fairly poor condition, was already identified by Connolly as "probably n.sp." The locality has been indicated on the map (fig. 42) by the letter M and an arrow northwest of the K.N.P.

Pseudoglessula hamiltoni has been named after the late Colonel James Stevenson Hamilton, first warden of the Kruger National Park and outstanding naturalist.

With a maximum length of slightly less than 18 mm., an average l/d of well over 3 and 10-11 whorls, the shell of *Pseudoglessula hamiltoni* differs considerably from the other much more obese (l/d 1·89-2·53) and larger species of the genus known to occur in Southern Africa. Only *P. gibbonsi* (Tayl.) is a smaller species, which, however, has only seven whorls and is considerably more obese (Connolly, 1939, p. 330; 14·9 × 7·9 mm., l/d 1·89). Related species occur in the Congo and East Africa, but few, if any, are as slender and have as many whorls as the present species (see e.g., Pilsbry, 1904-1905, 1919).

The discovery of *P. hamiltoni* was indeed the most outstanding result of the 1962 survey trip; the species was first discovered during an unscheduled stop on the Pafuri main road just west of the Thambyi Spruit. It is particularly gratifying that many specimens were obtained, enabling the author to achieve a world-wide distribution of type material.

Opeas lineare (Krauss, 1848), figs. 46-49

Bulimus linearis Krauss, *Südafr. Moll.* p. 78, pl. 5, fig. 3, 1848 (type locality: Bechuanaland, Mt. Mohapaani).

Euonyma linearis; Haas, *Abh. senckenb. naturf. Ges.* **431**, p. 102, 1936.

Opeas lineare; Connolly, *Ann. S. Afr. Mus.* **33**, p. 348, fig. 29E, 1939.

K.N.P.: Skukuza Rest Camp, S 7
Numbi Koppie, S 22
Skukuza Koppies, S 28
Near Lower Sabi Camp, S 33
Manung Koppie, S 35
Shabin Koppie, S 35
Ship Mountain, S 51
Godleni, S 74
Near Crocodile Bridge hippo pool, S 97
Beacon A, Lebombo Range, S 107
Gorge and surroundings, C 2
Bangu, C 12
Mbangari Koppie, C 47
Pumbe, C 52
Between Semane Koppie en Ngirivane Windmill, C 69
Shibotwane, C 72
Near Gudzane Dam, C 73
Timbavati Drift, C 77
Nwaswitsontso Koppies, C 87
Sweni firebreak, C 91
Nwaswitsontso R. bank W. of Kumane Dam, C 112
Near Orpen Dam, C 136
Nwamuriwa Hill, C 136
Koppie S. of koppie with Orpen plaque, C 148
Sand R. area, C 155
Western end of Saliji Road, C 155
Sabi R. area, C 162
Shalungwa Spring, N 16
Shantangalane, N 25
Near Machayi Pan, N 27
Mahlakuza Pan area, 'Msimbit' forest, N 28
Shantagalane Ridge, N 33
Nwambiya Pan, Nyandu sandveld, N 46
N. of Shingwedzi R., N 119
S. of Shingwedzi R., N 119
Shingwedzi R. near rocky waterhole, N 127
Tsange Koppie, N 136
Shibyatsangela Ridge, N 171
Shilowa Koppie, N 180
Mooiplaas plots, N 187
Macetse Koppie, N 191
Tsende plots, N 216
Koppie N. of Letaba R. causeway, N 225
W. of Letaba Camp, N 246

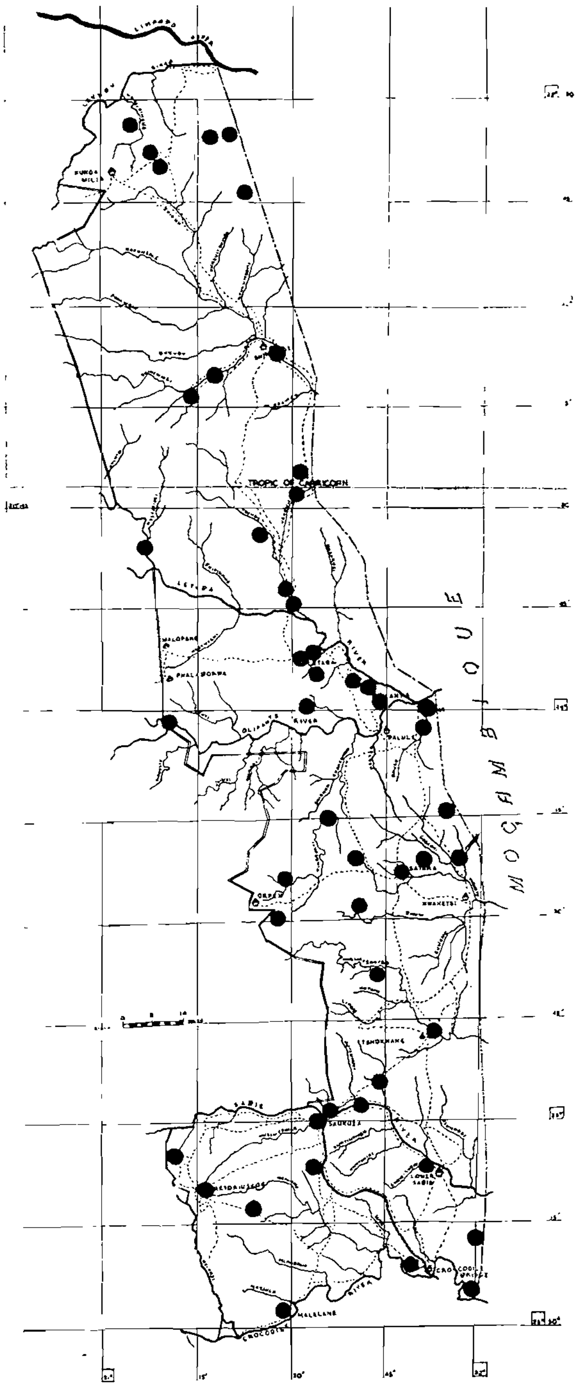


Fig. 46. Distribution in the Kruger National Park of *Opeas lineare* (Krss.).

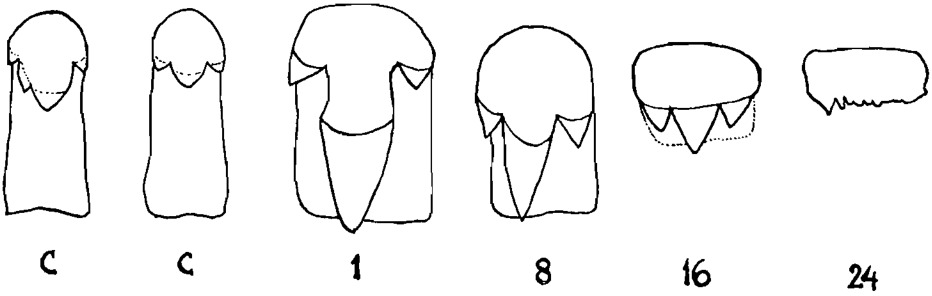
Letaba Rest Camp, N 247
Near Mbulweni Pan, N 257
Shithaburi, N 259
Along Shinobyeni Spruit, N 260
NW. of Olifants Camp, N 260
N. of Olifants Camp before 2nd Mangwanduna junction, N 260
Do., after 2nd etc., N 260
Mbulweni sandstone reef, N 269
Olifants Rest Camp, N 272
Mahulule Koppies, N 273

Haas (1936) was the first to record *Opeas lineare* from the K.N.P., viz., from the Malelane and Satara Rest Camps (blocks S 104 and C 71 respectively), which localities have been incorporated in the map (fig. 46); this is one of the only five species of terrestrial molluscs mentioned by Haas from the K.N.P.

Opeas lineare is widely distributed in Bechuanaland, Southern Rhodesia and the Transvaal; it occurs throughout the K.N.P. It shows a certain amount of variation, especially when specimens from widely separated localities are examined; on the whole, however, it is usually recognized without much difficulty, particularly on account of the size and sculpture. In the present author's opinion Connolly's var. *levis* is untenable, intermediates being found in almost every locality where the species occurs. The size varies somewhat too, a number of specimens being in excess of Connolly's shell of 14·3 mm. Measurements have been tabulated below:

Between Semane Koppie and Ngirivane Windmill	13·7 × 3·2 mm.,	9¼ whorls
	13·1 × 3·1 mm.,	9 ,,
Gorge and surroundings	14·4 × 3·3 mm.,	9½ ,,
Mbulweni sandstone reef	13·8 × 3·1 mm.,	9½ ,,
N. of Olifants Camp before 2nd Mangwanduna junction	14·7 × 3·2 mm.,	10 ,,
	14·6 × 3·3 mm.,	10 ,,
	14·3 × 3·2 mm.,	9½ ,,
Shithaburi	13·5 × 3·0 mm.,	9 ,,
W. of Letaba Camp	14·9 × 3·1 mm.,	10½ ,,
Mooiplaas plots	14·8 × 3·3 mm.,	9½ ,,
	14·6 × 3·5 mm.,	9½ ,,
	14·4 × 3·4 mm.,	10 ,,
	14·2 × 3·3 mm.,	9¼ ,,
	13·6 × 3·2 mm.,	9½ ,,
Shibyatsangela Ridge	15·0 × 3·3 mm.,	10¼ ,,
	(largest shell on record)	
	13·9 × 3·2 mm.,	10 ,,
	13·4 × 3·2 mm.,	9½ ,,

These specimens are the biggest available in the K.N.P. collection; the average size is naturally somewhat lower.



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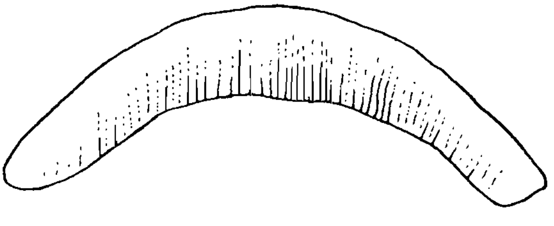

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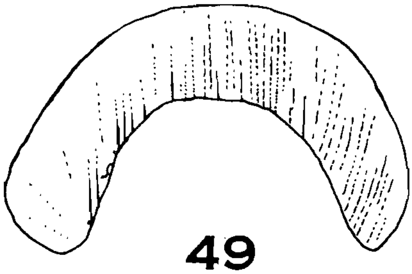

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Figs. 47-49. *Opeas lineare* (Krss.), 47. Radula elements (specimen from N. of Shingwedzi River); 48. Jaw, actual span 0·6 mm. (specimen from Mooiplaas plots); 49. Jaw, actual span 0·5 mm. (specimen from N. of Shingwedzi River). All figures highly enlarged.

Opeas lineare as a rule only occurs in sheltered spots, mainly under stones and rocks and sometimes under logs; one specimen was found on flowers in the Skukuza Rest Camp.

The animal is yellow, which in the field immediately distinguishes *Opeas lineare* from *Subulina mamillata* (Crvn.) and its smaller ally *S. gracillima* Conn. The jaw (figs. 48-49) varies from arc- to horseshoe-shaped and has a span of 0·5-0·6 mm. Two radulae have been examined, one from block N 187 having about 85 transverse rows with the formula 29—1—29 and another from block N 119 has about 95 rows and the formula 28—1—28; the radula measures 1·5 × 0·75 mm. Selected teeth from the radula from block N 119 are figured in fig. 47. Comparing this radula to description and figures of the radula of the type species *Opeas pumilum* (Pfr.) (cf. Pilsbry, 1946, p. 181, fig. 87) certain differences can be noticed. Only towards the very margin do the teeth become multicuspid in *O. lineare;* the central tooth is usually tricuspid, but sometimes an additional cusp may be seen on the left, which latter is presumably somewhat abnormal.

Xerocerastus burchelli (Gray, 1834), fig. 34, p. 354

Bulimus burchelli Gray, *Proc. zool. Soc. Lond.* 1834, p. 66, 1834 (type locality: near Lattakoo (Takun) = Kuruman, Cape of Good Hope).

Xerocerastus burchelli; Connolly, *Ann. S. Afr. Mus.* **29**, p. 303, pl. 3, figs. 12-15, 1930; Zilch, *Arch. Moll.* **71**, p. 230, figs. 26-27, 1939; Van Bruggen, *Ann. Transv. Mus.* **24**, p. 264, 1963; Van Bruggen, *Zool. Mededel. Leiden* **39**, p. 224, fig. 2, 1964.

K.N.P.: Hape Koppie, N 5
Shaluka, N 5
Eastern boundary, patch of 'Msimbit' forest, N 6
Eastern boundary, border of sandveld and grey soil, N 13
Eastern boundary, N. of Saselandonga Poort, N 20

The measurements in mm. of 27 adult shells from Shaluka are set out in a table below; they can be summarized as follows: 13·7—16·1 × 5·8—6·8 mm., l/d 2·14—2·53, average of 27 shells 2·36.

Table

16·1 × 6·7,	l/d 2·40	15·2 × 6·4,	l/d 2·37	14·5 × 6·2,	l/d 2·34
15·9 × 6·8	2·34	15·1 × 6·3	2·40	14·4 × 6·4	2·25
15·9 × 6·4	2·48	15·0 × 6·1	2·46	14·4 × 6·2	2·32
15·7 × 6·4	2·45	14·9 × 6·6	2·26	14·3 × 6·2	2·31
15·6 × 6·5	2·40	14·8 × 6·3	2·35	14·3 × 6·2	2·31
15·5 × 6·4	2·42	14·8 × 6·1	2·43	14·3 × 6·0	2·38
15·5 × 6·3	2·46	14·7 × 5·8	2·53	14·2 × 6·4	2·22
15·3 × 6·6	2·32	14·6 × 6·4	2·28	13·8 × 6·0	2·30
15·3 × 6·4	2·39	14·6 × 6·1	2·39	13·7 × 6·4	2·14

Consequently we have here a population with comparatively large and slender shells. The average l/d for populations from South West Africa and Bechuanaland Protectorate is 2.30 and the length of these shells varies between 11·0—15·1 mm. (see Van Bruggen, 1963b). The population of Hape Koppie is contiguous with that of Shaluka and has the same type of shell.

The population of block N 13 differs somewhat from the above-mentioned one, as witnessed by the figures of the next table, taken from 12 random adult shells. These can be summarized as follows: 13·8—15·8 × 6·0—6·6 mm., l/d 2·19—2·47, average of 12 shells 2·32.

Table

15·8 × 6·4,	l/d 2·47	14·4 × 6·2,	l/d 2·32
15·4 × 6·6	2·33	14·4 × 6·1	2·36
15·1 × 6·5	2·32	14·4 × 6·1	2·36
15·0 × 6·4	2·34	14·1 × 6·0	2·35
14·7 × 6·5	2·26	14·0 × 6·0	2·33
14·5 × 6·5	2·23	13·8 × 6·3	2·19

Five adult shells from Saselandonga Poort are again somewhat different; they may be summarized as follows: 13·7—14·4 × 6·3—6·5 mm., l/d 2·14—2·22, average of 5 shells 2·17. The actual measurements are:

14·4 × 6·5,	l/d 2·21
14·1 × 6·3	2·22
13·8 × 6·4	2·16
13·7 × 6·4	2·14
13·7 × 6·4	2·14

It appears that the populations tend to have longer and slenderer shells when one travels from south to north. Unfortunately available data are far too scanty to accept this as an established fact, but nevertheless the tendency seems unusually marked.

Xerocerastus burchelli is new to both the Transvaal and the K.N.P. So far it has only been found in the extreme northeast corner of the national park, which is entirely in accordance with the distribution pattern of the species. *X. burchelli*, though endemic to the Southern African subregion, is widely distributed throughout the Cape of Good Hope (mainly north of the Orange River), South West Africa (Great Namaqualand and Damaraland), Bechuanaland and the Northern Transvaal (Limpopo River valley). The species provides one of the few examples of the utilisation of the Limpopo River corridor as a means of connection between the arid interior and the tropical lowlands of East Africa. This has been fully discussed in Van Bruggen, 1964b.

Shells of this species are usually commonly found lying on the ground between the scattered dry vegetation. The species is obviously adapted to a rather open, very dry and hot habitat. Empty shells are almost always white, those of live specimens uniformly pale brown.

Euonyma varia Connolly, 1910, fig. 34, p. 354

Euonyma varia Connolly, *Ann. Mag. nat. Hist.* (8) **6**, p. 263, pl. 6, figs. 5-7, 1910 (type locality: Transvaal, Pienaars Poort); Connolly, *Ann. S. Afr. Mus.* **33**, p. 341, 1939.

K.N.P.: Shithlave Kop, S 36

It is remarkable that among the many hundreds of subulinids collected in the K.N.P. so far only one sample of a species of *Euonyma* has been detected. The few Transvaal records of this genus seem to indicate that it is apparently more or less confined to the Highveld and the present record of *Euonyma varia* is the first for the Lowveld; the species is new to the K.N.P.

The sample from Shithlave Kop consists of only one adult shell and some juveniles; the one full-grown shell measures 16·4 × 4·1 mm. and has 9 whorls.

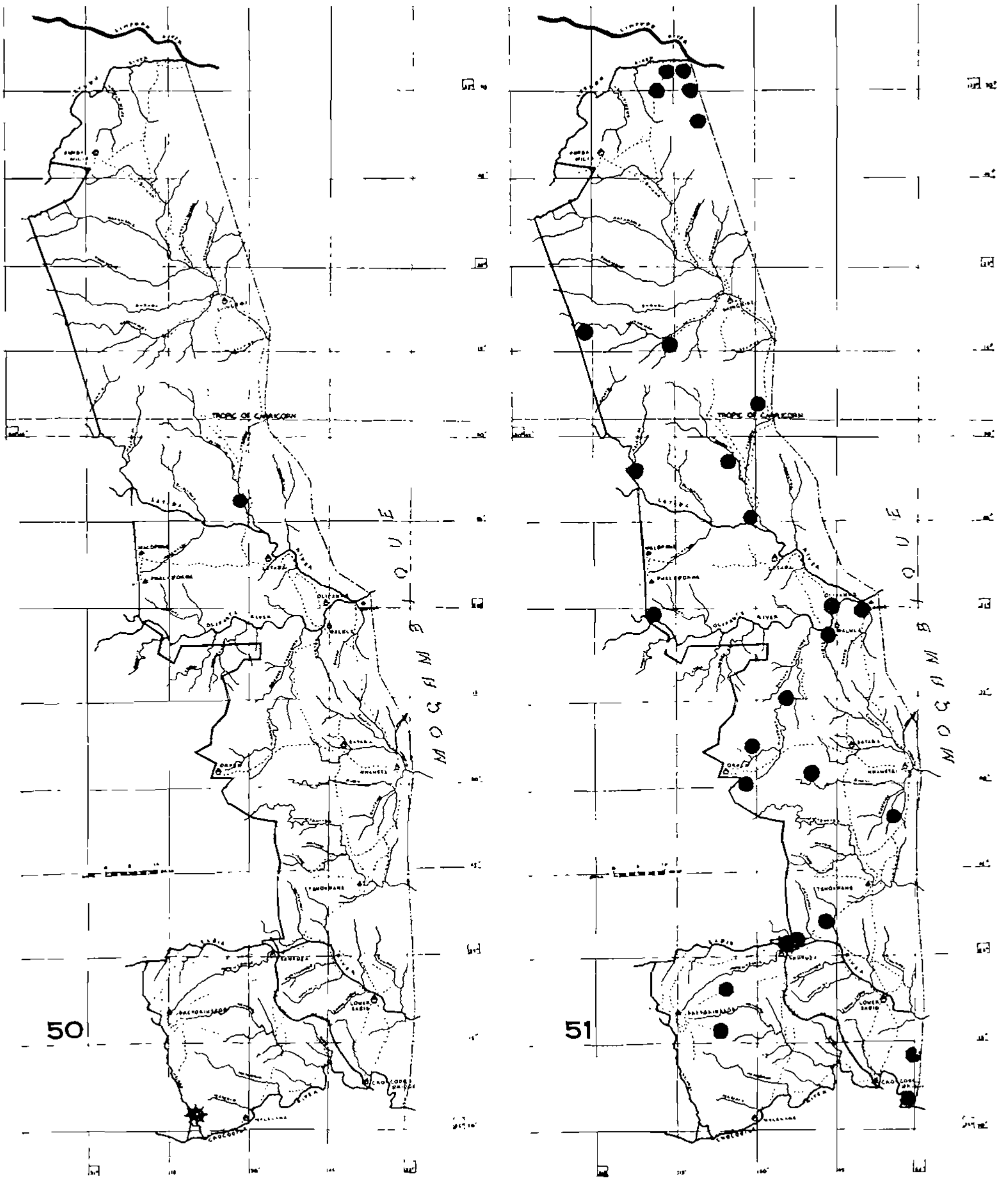
Family ACHATINIDAE

Achatina bisculpta Smith, 1878, fig. 50

Achatina bisculpta Smith, *Quart. J. Conch.* **1**, p. 349, 1878 (type locality: South Africa); Connolly, *Ann. S. Afr. Mus.* **33**, p. 314, 1939; Bequaert, *Bull. Mus. comp. Zool. Harvard* **105**, p. 13, 1950; Van Bruggen, *Rev. Zool. Bot. afr.* **71**, p. 80, 1965.

K.N.P.: Tsende plots, N 216

So far *Achatina bisculpta* has only been found at the Tsende plots, all available material consisting of one adult shell, some juveniles and fragments. The adult shell has 7½ whorls and measures 55·5 × 27·9 mm., l/d 1·99, thus proving that it grows well over the 47 mm. with 7 whorls as recorded by Connolly (1939). The only indication at present that the species is more widely distributed in the K.N.P. is some fragments found on the northern



Figs. 50-51. Distribution in the Kruger National Park of 50. *Achatina bisculpta* Smith (dot), and *Archachatina subcylindrica* (Prest.) (star); 51. *Achatina immaculata* Lam.

banks of the Olifants River. Few specimens are as yet known and present data show that it seems restricted to the Transvaal; the anatomy has not been described so far. *A. bisculpta* is new to the K.N.P.

Achatina (*Lissachatina*) *immaculata* Lamarck, 1822, figs. 51-53

Achatina immaculata Lamarck, *Hist. Nat. Anim. s. Vert.* **6**, 2, p. 128, 1822 (no locality known to the author, type locality restricted here to Lourenço Marques, Mozambique); Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 167, 1925; Germain, *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80**, p. 38, 1935; Connolly, *Ann. S. Afr. Mus.* **33**, p. 324, 1939; Bequaert, *Bull. Mus. comp. Zool. Harvard* **105**, p. 50, 1950; Mermod, *Rev. Suisse Zool.* **58**, p. 740, figs. 86a-b, 1951; Braga, *An. Junta Invest. Ultram.* **7**, 3, p. 121, pl. 13, 1952; Van Bruggen, *Rev. Zool. Bot. afr.* **71**, p. 80, 1965.

Helix (*Cochlitoma*) *panthera* Férussac, *Hist. Nat. Moll. Terr. Fluv. Atlas*, pl. 126, figs. 1-2, 1832 (no locality).

Achatina panthera; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 166, 1925; Connolly, *Ann. S. Afr. Mus.* **33**, p. 322, 1939; Bequaert, *Bull. Mus. comp. Zool. Harvard* **105**, p. 98, pl. 5, fig. 3, pl. 34, fig. 1, pl. 38, fig. 2, pl. 56, fig. 2, pl. 57, fig. 1, pl. 58, fig. 3, 1950; Mead, *Bull. Mus. comp. Zool. Harvard* **105**, p. 226, fig. 21, 1950; Barnard, *Beginn. Guide S. Afr. Shells*, p. 149, 1951; Van Bruggen, *Rev. Zool. Bot. afr.* **71**, p. 80, 1965.

K.N.P.: Pretoriuskop-Skukuza Road, S 25
Ship Mountain, S 51
Godleni, S 74
Beacon A, Lebombo Range, S 107
Gorge and surroundings, C 2
Along main road just S. of Olifants R., C 24
Mbangari Koppie, C 47
Just past Timbavati Drift, C 77
Nwaswitsontso Koppies, C 87
Sweni firebreak, C 91
Makonkolweni Spruit, C 115
Koppie S. of koppie with Orpen plaque, C 148
Sand R. area, C 154
Sabi R. area, C 162
Shaluka, N 5
Eastern boundary, patch of 'Msimbit' forest, N 6
Near Thambyi Spruit, Pafuri main road, N 11
Eastern boundary, border of sandveld and grey soil, N 13
Eastern boundary, sandveld, N 28
Shangoni Koppies, N 122
Tsange Koppie, N 136
Shibyatsangela Ridge, N 171
Shipandane Drift, Tsende R., N 187
Macetse Koppie, N 191
Koppie N. of Letaba R. causeway, N 225
N. of Olifants Camp, N 272
Olifants Rest Camp, N 272
Mahulule Koppies, N 273

Achatina immaculata and *A. panthera* (Fér.) have long been considered separate species and an examination of the type specimens (unfortunately all without localities) indeed induces one to agree with this. Fortunately accurate descriptions and figures are available (Pilsbry, 1904-1905; Bequaert, 1950; Mermod, 1951). A comparison of the type shells of Lamarck and the type figure of Férussac results in the following table.

	A. immaculata	*A. panthera*
measurements	150 × 77·5 mm. 144 × 77·5 mm.	151 × 75 mm.
l/d	1·94, 1·86	2·01
last whorl/length shell	0·77, 0·80	0·75
length ap./length shell	0·57, 0·60 (aperture more than half as long as shell)	0·50 (aperture about half as long as shell)
body whorl	markedly inflated	slightly inflated
colour	body whorl almost uniformly dark because of very close flames, earlier whorls with more widely spaced flames	whitish with few widely spaced broad flames

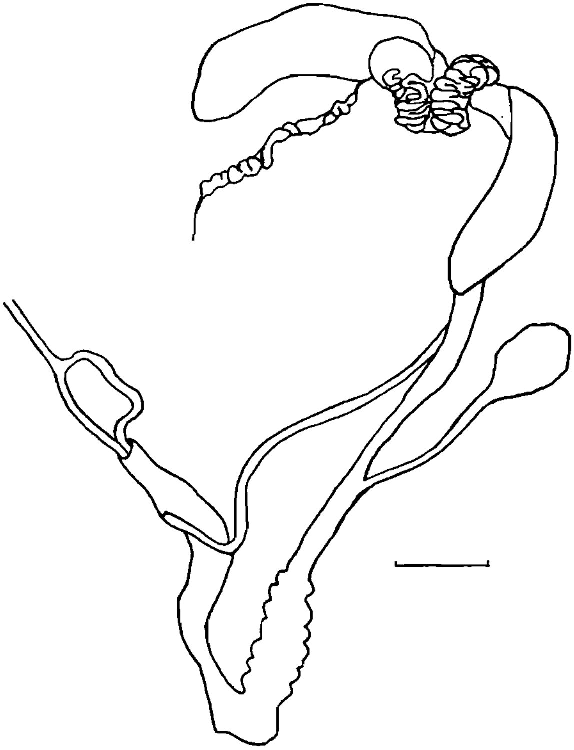


Fig. 52. *Achatina immaculata* Lam. from N. of Olifants Camp, genitalia, scale 10 mm., figure enlarged.

Obviously these represent two easily separated taxa. However, as soon as more abundant material becomes available, intermediate specimens disturb the picture. Among the K.N.P. material the l/d varies from 1·63 to 2·12+, both types of pattern (sometimes even on one shell!) with all intermediates occur and it becomes generally impossible to divide the shells into the above categories. At this stage Bequaert's suspicion (Bequaert, 1950, p. 100) that *A. panthera* (Fér.) is either a subspecies or a synonym of *A. lamarckiana* seemed worth investigating.

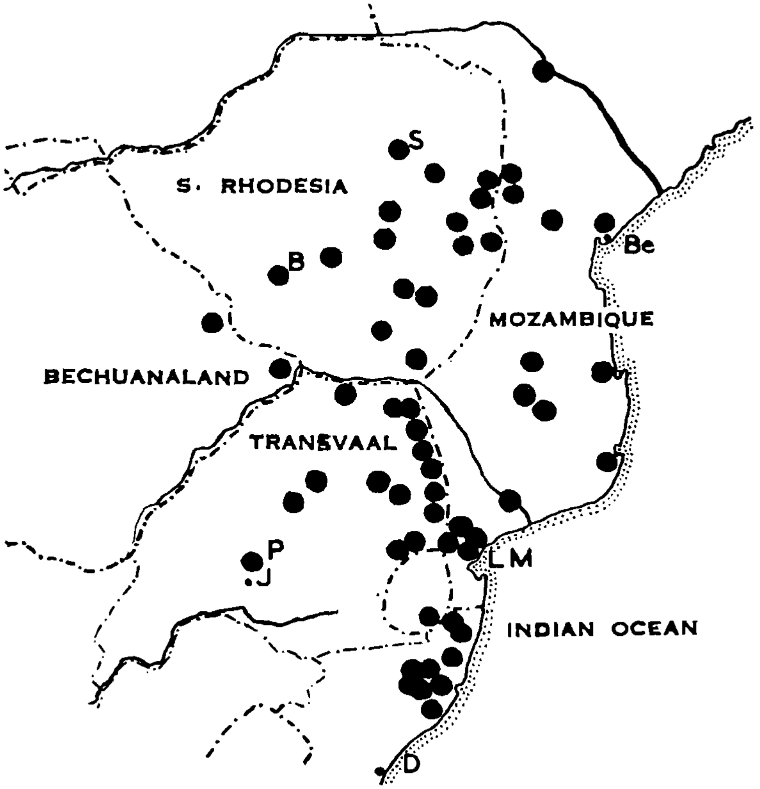


Fig. 53. General distribution in Southern Africa of *Achatina immaculata* Lam. B = Bulawayo, Be = Beira, D = Durban, J = Johannesburg, LM = Lourenço Marques, P = Pretoria, S = Salisbury.

The measurements of the K.N.P. material may be summarized as follows: 102—131+ × 52·4—70·5 mm., l/d 1·63—2·12, average of 55: l/d 1·81. In addition numerous specimens from Zululand, Swaziland, Transvaal, Mozambique and S. Rhodesia (mainly NM, also some in the Transvaal Museum) were examined and it was found that it is impossible to distinguish the *immaculata* and *panthera* varieties. The obese *immaculata* form is somewhat more common than the more slender *panthera* form, which latter is certainly more common north of the Zambezi River (see e.g., data of Bequaert, *op. cit.*, p. 108, l/d 1·92, 1·89, 1·95, 1·84, 1·96).

Dissection of the genitalia of more than a dozen spirits specimens with various types of shells from all over Southern Africa has resulted in a uniform picture of genitalia as described and figured for *A. panthera* (Fér.) (vide Mead, 1950, and others quoted by him). The genitalia (fig. 52) all show the characteristic loop at the apex of the penis and the compound folds of the basal vagina; certain minor differences may confidently be attributed to individual variation. Among the dissected specimens are also representatives of *A. panthera* var. *lamarckiana* Pfr. (S. Rhodesia, Mount Selinda, Chirinda Forest, NM); the genitalia of these also agree with those of the others and Mead's descriptions.[6]

All this inevitably leads to the conclusion that at least south of the Zambezi there is only a single species of large *Achatina* with a pink columella, for which the oldest available name is *Achatina immaculata* Lamarck, 1822. Consequently the name *A. panthera* Férussac, 1832, has to be relegated to the synonymy of *A. immaculata*. It is convenient to restrict the type locality to Lourenço Marques (Mozambique), because it is most likely that Lamarck's shells were obtained near this old port city. The species is widely distributed (fig. 53) from Zululand in the south to as far west as Francistown in Bechuanaland (*new record*, NM); the record "Durban" (Connolly, 1939) has to be expunged, because the species obviously does not cross the Tugela River and has never been collected in Natal proper. In the forests of the Eastern Escarpment in Rhodesia and Mozambique (and also at certain other places) the typical large form is replaced by the smaller var. *lamarckiana* Pfr.

The colour of the animal varies considerably and changes in the course of its life (vide Rees, 1950); two specimens from block N 272 can be described as yellowish orange (one darker than the other), while another from block N 6 is rather pale yellowish brown (field notes).

A. immaculata has already been recorded for the K.N.P., viz., by Connolly (1939) on p. 324 sub Transvaal: "Game Reserve (Miss Wilman)". Unfortunately the specimens could not be traced in the Alexander McGregor Memorial Museum in Kimberley (C.P.). The species is widely distributed throughout the K.N.P.; it is adapted to a variety of habitats and climates and survives even in dry areas, which generally support a poor mollusc fauna.

The following selected measurements will demonstrate the variability of the species:

locality	*length*	*max. diam.*	*l/d*
N 187	131+	70·3 mm.	1·86+
N 23	126·0	69·9 mm.	1·80
N 122	125+	70·5 mm.	1·77+
C 154	119·0	65·2 mm.	1·82
N 6	117+	64·7 mm.	1·81+
S 51	116+	57·3 mm.	2·02+
N 23	115+	63·5 mm.	1·81+
N 23	111+	52·4 mm.	2·12+
C 2	103·0	63·0 mm.	1·63
C 77	102·0	60·7 mm.	1·68

[6] Mead's fig. 21 is somewhat misleading as far as the insertion of the penial retractor muscle is concerned; usually it is inserted at the top of the loop and not lower down as figured by him.

Archachatina (*Tholachatina*) *subcylindrica* (Preston, 1909), fig. 50, p. 370

Achatina subcylindrica Preston, *Ann. Mag. nat. Hist.* (8) **3**, p. 182, pl. 7, fig. 8, 1909 (type locality: "Natal"); Connolly, *Ann. S. Afr. Mus.* **33**, p. 310, pl. 11, fig. 7, 1939.

Archachatina pentheri subcylindrica; Bequaert, *Bull. Mus. comp. Zool. Harvard* **105**, p. 202, 1950.

? *Achatina subcylindrica deisenbecki* Blume, *Arch. Moll.* **81**, p. 61, fig., 1952 (type locality: Farm Friedenheim near Nelspruit, Transvaal).

K.N.P.: Machuluane Mountains, S 101

Some very weathered shells have been identified with Preston's *Achatina subcylindrica.* This species is very problematic, which is shown by Bequaert (1950), who considers it a subspecies of *A. pentheri* Stur., and Blume (1952), who agrees with Connolly (1939) in keeping *A. subcylindrica* separate, at the same time describing a new subspecies, *deisenbecki*, from near Nelspruit. The present author is inclined to agree to keep *A. subcylindrica* separate, because *A. pentheri* Stur. belongs to a group with vivid flame pattern, while the forms under discussion are all unicoloured.

Measurements in mm. of available and recorded specimens are tabulated below:

	shell	*l/d*	*length apert.*	*l. shell/ l. apert.*	*whorls*
1. K.N.P...	43·2 × 15·8	2·73	14·6	2·96	7½
2. K.N.P...	41+ × 15·1	2·71+	14·5	2·83+	7¼
3. K.N.P...	41·0 × 15·1	2·71	14·2	2·89	7
4. K.N.P...	40·5 × 15·5	2·61	13·5	3·00	7¼
5. type Preston ..	38·5 × 13·5	2·85	13·0	2·96	7½
6. shell Connolly ..	46·5 × 18·0	2·58	15·0	3·10	8
7. type *deisenbecki* ..	50·5 × 20·0	2·52	19·0	2·66	8½
8. paratype do. ..	60·4 × 20·3	2·97	20·4	2·96	9¼
9. paratype do. ..	50·0 × 19·0	2·63	19·3	2·58	—
10. paratype do. ..	47·6 × 18·2	2·61	18·3	2·60	—
11. paratype do. ..	47·2 × 18·5	2·55	19·0	2·48	—
12. paratype do. ..	45·6 × 18·7	2·43	18·0	2·53	—

An examination of the table shows that, except the one abnormal paratype of *A. s. deisenbecki* Blume (no. 8), the material falls into two groups, viz., nos. 1-5: 38·5—43·2 × 13·5—15·8 mm., l/d 2·61—2·85, length aperture 13·0—14·6, length shell/length aperture 2·83+—3·00, and nos. 6-7, 9-12: 45·6—50·5 × 18·0—20·0 mm., l/d 2·43—2·63, length aperture 15·0—18·0, length shell/length aperture 2·48—3·10. Whatever the status of Blume's *A. deisenbecki,* it is clear that the K.N.P. material comes closest to *A. subcylindrica.*

A further complication is that no exact locality has been recorded for *A. subcylindrica;* the type came from "Natal" and Connolly's shell from "South Africa". The complete absence of anything like Preston's species in the Natal Museum contributes to the suspicion about the correctness of the type locality.

Study of the genitalia is essential for understanding this species; it is indeed not unlikely that it is restricted to the southern parts of the Transvaal Lowveld, showing a fair measure of variation. In the author's opinion further material will prove that the "gap" between *A. subcylindrica* and *A. deisenbecki* Blume can be closed, relegating the latter name to the synonymy of the former[6a].

A. subcylindrica is new to the K.N.P.

Family RHYTIDIDAE

Nata vernicosa (Krauss, 1848), fig. 54

Helix vernicosa Krauss, *Südafr. Moll.* p. 76, pl. 4, fig. 23, 1848 (type locality: Natal).

Nata vernicosa; Connolly, *Ann. S. Afr. Mus.* **33**, p. 99, fig. 6, pl. 4, figs. 4-5, 1939; Zilch, *Handb. Paläozool.* **6** (2), fig. 1936, 1960.

K.N.P.: Ship Mountain, S 51
Sand R. area, C 155
Sabi R. area, C 162

Nata vernicosa, new to both the Transvaal and the K.N.P., is distributed throughout the Eastern Cape Province, Natal and Zululand. The endemic genera *Natalina* Pilsbry, 1893, and *Nata* Watson, 1934, are the only representatives of the family Rhytididae in the Ethiopian Region; they range from the Cape Peninsula to just north of Lourenço Marques, but do not venture far inland. In addition to the species in question only *Nata viridescens* (M. & P.) is known to occur in the Transvaal; the westernmost locality is Pretoria.

In the K.N.P. *N. vernicosa* has so far only been found on Ship Mountain and the island between the Sabi and Sand Rivers. From an ecological point of view the presence of predators in the latter area with its many snails is no reason for surprise.

Family APERIDAE

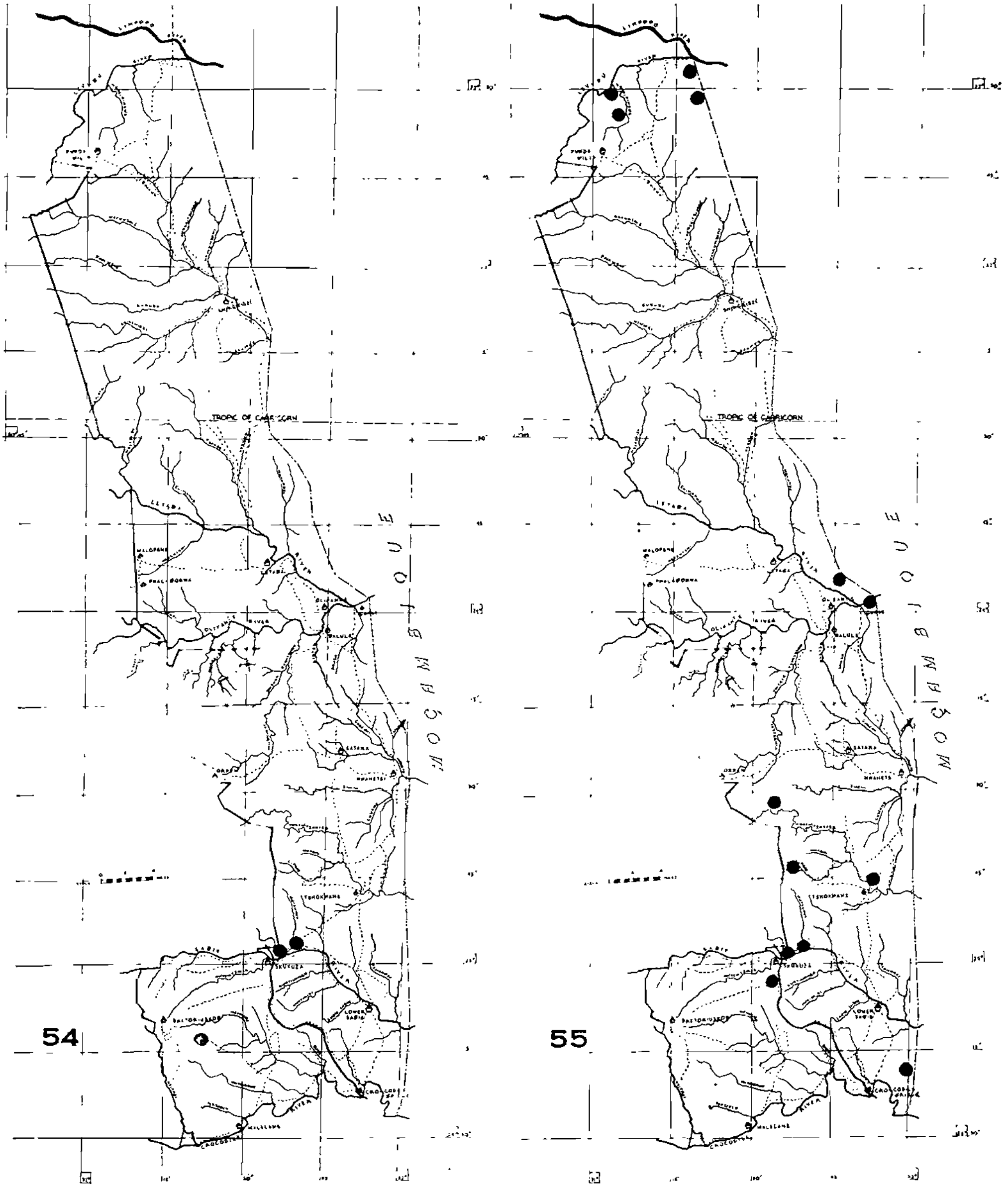
Species of the family Aperidae are discussed in the chapter on slugs.

Family STREPTAXIDAE

The family Streptaxidae is represented in the K.N.P. by at least eight species. All species in this group are predatory on invertebrates. Species of the widely distributed genus *Gulella* have not been treated to any detail because of a forthcoming revision of the Southern African species by the present author. For this reason no subgenera have been mentioned.

Undoubtedly the most spectacular result of the mollusc survey of the K.N.P. is the discovery of three new species of *Streptostele*, a tropical genus hitherto scarcely known south of the Zambezi and completely new to the area south of the Limpopo.

[6a] *Archachatina transvaalensis* (Smith, 1878), of which the shell may be as long as 42 mm. (cf. Connolly, 1939, p. 309), is also closely allied to the *A. subcylindrica-deisenbecki* complex, which latter may eventually prove to be a synonym of *A. transvaalensis.*



Figs. 54-55. Distribution in the Kruger National Park of 54. *Nata vernicosa* (Krss.) and 55. *Gonaxis gwandaensis* (Prest.).

Gonaxis gwandaensis (Preston, 1912), figs. 55-57

Streptaxis gwandaensis Preston, *Ann. Mag. nat. Hist.* (8) **9**, p. 69, fig. 1, 1912 (type locality: near Geelong Mine, Gwanda District, S. Rhodesia).

Gonaxis gwandaensis; Connolly, *Trans. R. Soc. S. Afr.* **12,** p. 110, 1925; Bequaert & Clench, *J. Conch.* **20,** p. 264, 267, 1936; Connolly, *Ann. S. Afr. Mus.* **33,** p. 14, 1939; Verdcourt, *Corynd. Mus. Occ. Pap.* **8,** p. 17, 1961; Van Bruggen, *Ann. Transv. Mus.* **24,** p. 268, fig. 5, 1963.

K.N.P.: Nahpe Road, S 17
Godleni, S 74
Olifants R. Poort area, C 3
Talamati, C 100
Near Hlangulene, C 125
Nwamuriwa Hill, C 136
Sand R. area, C 154
Sand R. area, C 155
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Madzaringwe Poort, N 8
Eastern boundary, grey soil, N 13
Madzaringwe Spruit, N 16
Ramiti Pan area, N 250

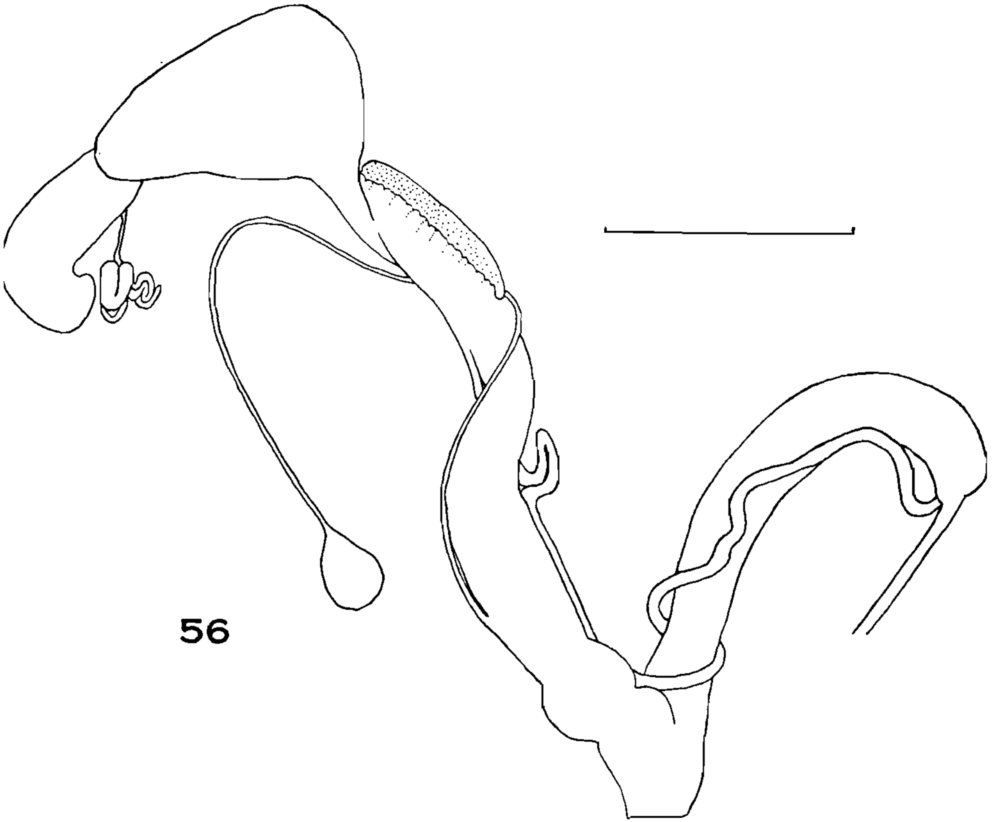
Specimens of *Gonaxis gwandaensis* of the K.N.P. greatly extend our knowledge of the distribution of this species, which up to now was only known from four localities in Bechuanaland, S. Rhodesia, and Mozambique. Thus it is new for South Africa, the Transvaal and the K.N.P.; more details about the distribution can be found in Van Bruggen (1963a, 1963b). The southernmost limit of this species is in the Mkuzi Game Reserve, Zululand (Natal Museum, *new record*), which at the same time is also the southernmost limit of all species of *Gonaxis* sensu Connolly, 1939, in Africa. Most species of *Gonaxis* occur in the tropics of Africa, only five crossing the Zambezi River, of which again only two occur south of the Limpopo River. *Gonaxis* s.l. is thus clearly tropical in its distribution.

In the K.N.P. *G. gwandaensis* appears to be widely distributed but nowhere common, except on the island between the Sabi and Sand Rivers (blocks C 154, 155). This species is carnivorous and its presence on this island with its rich pulmonate fauna is therefore no surprise (see also sub *Nata vernicosa* (Krss.)).

The available shells show some variation in size and shape as illustrated by the following measurements (all represent greatest length and maximum diameter):

Godleni	17·1 × 11·8 mm.	Sand R. area	16·0 × 12·0 mm.
Eastern bound.	16·8 × 12·0 mm.		15·7 × 11·8 mm.
	16·6 × 11·7 mm.	Nwamuriwa Hill	15·8 × 11·3 mm.
Nahpe Road	16·1 × 12·0 mm.		
	16·0 × 11·6 mm.		
	16·0 × 11·5 mm.		

A spirits specimen from block C 154 was dissected in order to obtain the genitalia and radula, both being undescribed for the present species (fide Connolly, 1939, and Verdcourt, 1961b). The shell, which had to be sacrificed, measured 16·5 × 12·3 mm.



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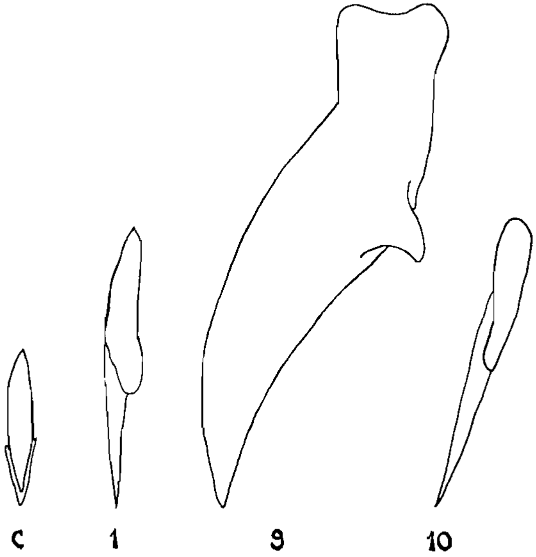

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Figs. 56-57. *Gonaxis gwandaensis* (Prest.) from Sand River area, 56. Genitalia, scale 4 mm. and 57. Radula elements. All figures highly enlarged.

The genitalia are figured in fig. 56. The fairly long penis is completely enclosed in a thick muscular sheath. The vas deferens is long, springs from the apex of the penis sheath and reaches the peniovaginal angle; it makes a conspicuous loop before joining the common duct. The spermatheca has the usual long duct. The numerous blackish brown spinules inside the penis may be seen through the semitransparent sheath. Except for the insertion of the vas deferens the genitalia of *G. gwandaensis* resemble those of *G. quadrilateralis* (Prest.) as figured by Verdcourt (*loc. cit.*, p. 9, fig. 10).

The pharynx is long (approximately 8 mm.) and muscular; the radula (fig. 57) measures 10·5 × 1·2 mm. and contains about 40 transverse rows. The rows are V-shaped and the formula is 20—(1)—20. Sometimes a weak central tooth may be present, particularly in the part which is still not fully chitinized. The lateral teeth gradually increase outwards to the ninth, after which there is a gradual decrease in size.

A shell found by Dr. E. L. Gill in the "Sabi Game Reserve" (South African Museum No. A 7230, Cape Town) in 1927 is probably the first specimen of *G. gwandaensis* to be collected in the K.N.P.

Streptostele (Raffraya) meridionalis n.sp., figs. 58, 60, 63

A medium-sized species of *Streptostele*, subgenus *Raffraya*, mainly characterized by whorls that are hardly impressed at the suture.

Shell (fig. 58) small, elongate, almost imperforate, glossy, somewhat translucent, creamy white. Spire produced, tapering towards apex, narrow, apex rounded. Whorls 7-8, gradually increasing, very little convex, almost flat and only very slightly granulate under high magnification, remainder sculptured with well-raised, straight, almost vertical ribs, which are rather widely spaced, interstices smooth, slightly granulate under high magnification, interstices on body whorl about two times as wide as ribs; ribs number about 26 on the body whorl. Suture shallow, somewhat impressed, crenellate. Aperture (fig. 60) subpiriform with a very small parietal tooth and a well-developed blunt labral tooth, slightly above the middle of the outer lip; base broadly rounded, seen in profile the outer lip is only very slightly outcurved, receding somewhat towards the base; columella straight and vertical, incrassate, smooth. Peristome thickened and reflected.

Animal unknown.

Measurements of shell:

length 4·4 mm. (holotype), 4·5 mm. (paratype);

maximum diameter 1·1 mm. (holotype), 1·1 mm. (paratype), l/d 4·00 (holotype), 4·09 (paratype);

length last whorl 1·6 mm. (holotype), 1·6 mm. (paratype);

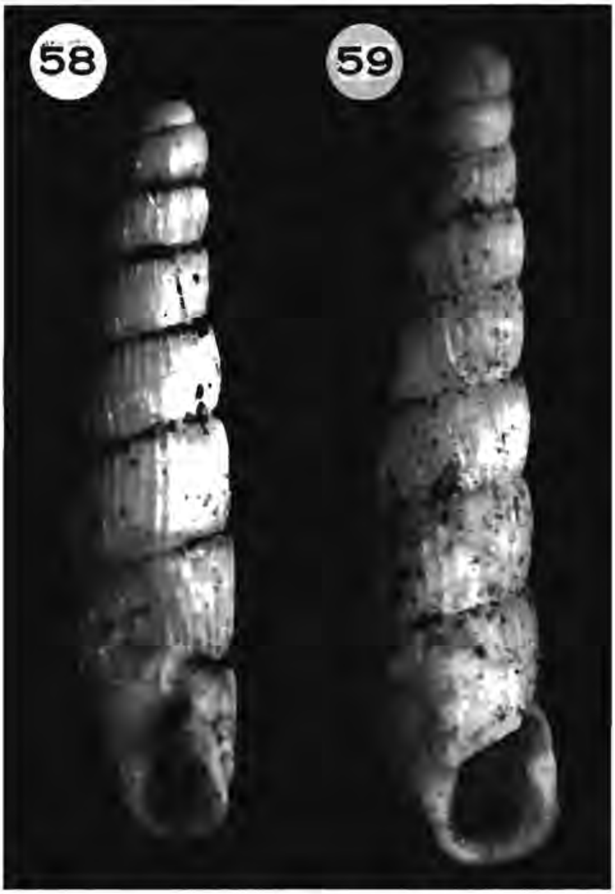
length aperture 1·0 mm. (holotype), 0·9 mm. (paratype);

width aperture 0·8 mm. (holotype), 0·8 mm. (paratype) (aperture measurements have been taken externally).

Holotype: South Africa, Transvaal, Kruger National Park, between Semane Koppie and Ngirivane Windmill, block C 69, 28.II.1964, leg. A. C. van Bruggen c.s., in collection Natal Museum, Moll. No. 4210, Type No. 1114.

Paratype: Kruger National Park, Dzundweni Hill, block N 50, 25.II.1964, leg. A. C. van Bruggen c.s., in collection K.N.P., Skukuza.

Streptostele meridionalis is closely allied to *S. herma* Conn. from the Victoria Falls, from which it may be told apart by the flat whorls, which are scarcely impressed at the suture. This new species, only the third of the genus to become known from Southern Africa, is the southernmost representative of both genus and subgenus (*meridionalis* Lat. = of the South), extending the known limits of its distribution (Mozambique, Mount Gorongosa, vide Van Bruggen, 1964a) approximately 450 miles southward.



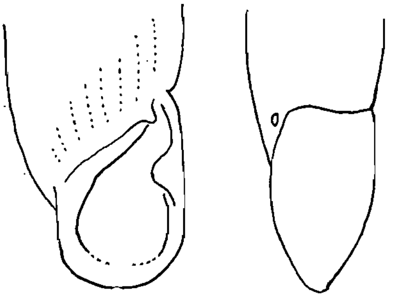
Figs. 58-59. 58. *Streptostele meridionalis* nov. spec., holotype; 59. *Streptostele sanctuarii* nov. spec., holotype. Figures highly enlarged. Photographs B. R. Stuckenberg.

Fig. 62 outlines the distribution of *Streptostele* in Southern Africa (according to Connolly, 1922, 1939; Van Bruggen, 1964a; present material and Natal Museum records), the two localities near Umtali and the one near Lundi (Eastern S. Rhodesia) being *new records*. The genus is tropical in its general distribution pattern, numerous species being known from West, Central and East Africa, and also from the Comoros, Seychelles and Mascarene Islands in the Western Indian Ocean. This is another example of the presence of a tropical element in almost all groups of animals and plants of the K.N.P.

Streptostele (Raffraya) sanctuarii n.sp., figs. 59, 61, 63

A large and slender species of *Streptostele*, subgenus *Raffraya*, with nine whorls and well-developed labral tooth.

Shell (fig. 59) small, elongate, almost imperforate, fairly glossy, slightly translucent, creamy white. Spire produced, tapering towards apex, very narrow, apex rounded. Whorls nine, gradually increasing, little convex, almost flat, but impressed at the suture, first two smooth and slightly granulate under high magnification, remainder sculptured with well-raised, straight, almost vertical ribs, which are rather widely spaced, interstices smooth, slightly granulate under high magnification, interstices on body whorl 2-3 times as wide as ribs, ribs number about 34 on body whorl. Suture shallow, but impressed, slightly crenellate. Aperture (fig. 61) comparatively short and almost square, with an almost imperceptible parietal callosity and a well-marked, blunt labral tooth at about one-third from the apex of the lip; base broadly rounded, seen in profile the outer lip is very slightly outcurved, receding somewhat towards the base; columella straight and vertical, incrassate, smooth. Peristome thickened and reflected.



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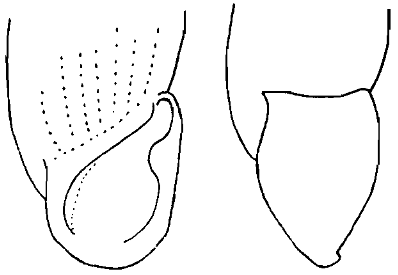


61

Figs. 60-61. Different views of the aperture of 60. *Streptostele meridionalis* nov. spec., holotype and 61. *S. sanctuarii* nov. spec., holotype. All figures highly enlarged.

Animal unknown.

Measurements holotype shell:
length 5·4 mm.;
maximum diameter 1·3 mm., l/d 4·15;
length last whorl 1·6 mm.;
length aperture 1·0 mm., width aperture 0·9 mm. (aperture measurements have been taken externally).

Holotype: South Africa, Transvaal, K.N.P., Olifants Rest Camp, steep rocky slope facing the river, block N 272 (fig. 63), 23.II.1964, leg. A. C. van Bruggen c.s., in collection Natal Museum, Moll. No. 4211, Type No. 1115.

Streptostele sanctuarii is easily distinguished from its congeners in Southern Africa (and further north as well) by its slender spire, great length, high number of whorls and well-developed labral tooth.

This beautiful new species has been named *S. sanctuarii* as a reference to the National Park in which it has first been collected (*sanctuarium* Lat. = sanctuary, game reserve, national park). It is only the fourth species of *Streptostele* to become known for the subcontinent south of the Zambezi River.

Streptostele n.sp., fig. 63

K.N.P.: Shaluka, N 5

A juvenile shell of a slender and smooth species of *Streptostele* was obtained at Shaluka in 1964. This little shell only shows marked growth striae and no raised ribs at all. All

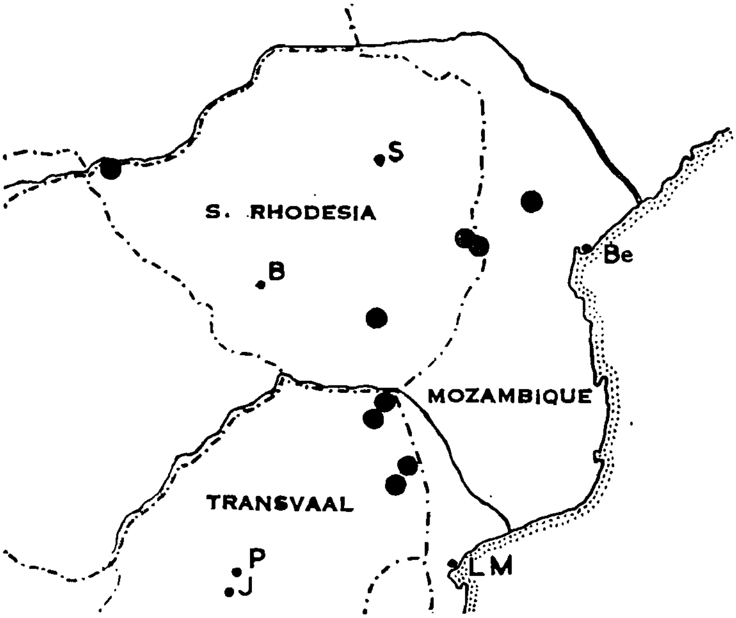


Fig. 62. Distribution of the genus *Streptostele* in Southern Africa. B = Bulawayo, Be = Beira, J = Johannesburg, LM = Lourenço Marques, P = Pretoria, S = Salisbury.

Southern African species of the genus have well-marked vertical ribs and consequently it represents an as yet undescribed species.

With the increase in knowledge of the genus *Streptostele* in Southern Africa it now becomes necessary to summarize available data in a key based on shell characters. All five species occurring south of the Zambezi River have been included.

Key to Southern African *Streptostele*

1 *a* Shell with growth striae only .. .. unnamed spec. (see above)
  b Shell with raised ribs 2
2 *a* Shell with maximum diameter half-way the spire; almost toothless, nine whorls, 4·1 × 1·0 mm., l/d 4·1 .. .. *S. inconspicua* Van Bruggen, 1964
  b Shell with maximum diameter on or near body whorl 3
3 *a* Shell well over 5 mm. long, nine whorls; labral tooth well developed, 5·4 × 1·3 mm., l/d 4·15 .. .. *S. sanctuarii* n.sp.
  b Shell up to or slightly over 4·5 mm. long, seven to eight whorls 4
4 *a* Teeth little developed, whorls slightly convex, impressed at the suture, seven whorls, 4·0—4·5 × 1·1—1·3 mm., l/d 3·46—3·64 .. .. .. *S. herma* Connolly, 1912
  b Well-developed labral tooth, whorls flat, scarcely impressed at the suture, seven to eight whorls, 4·4—4·5 × 1·1 mm., l/d 4·00—4·09 .. .. *S. meridionalis* n.sp.

Gulella crassilabris (Craven, 1880), fig. 64

Ennea crassilabris Craven, *Proc. zool. Soc. Lond.* 1880, p. 616, pl. 57, fig. 5, 1880 (type locality: Lydenburg).
Gulella crassilabris; Connolly, *Ann. S. Afr. Mus.* **33,** p. 32, 1939.

K.N.P.: Koppie S. of koppie with Orpen plaque, C 148

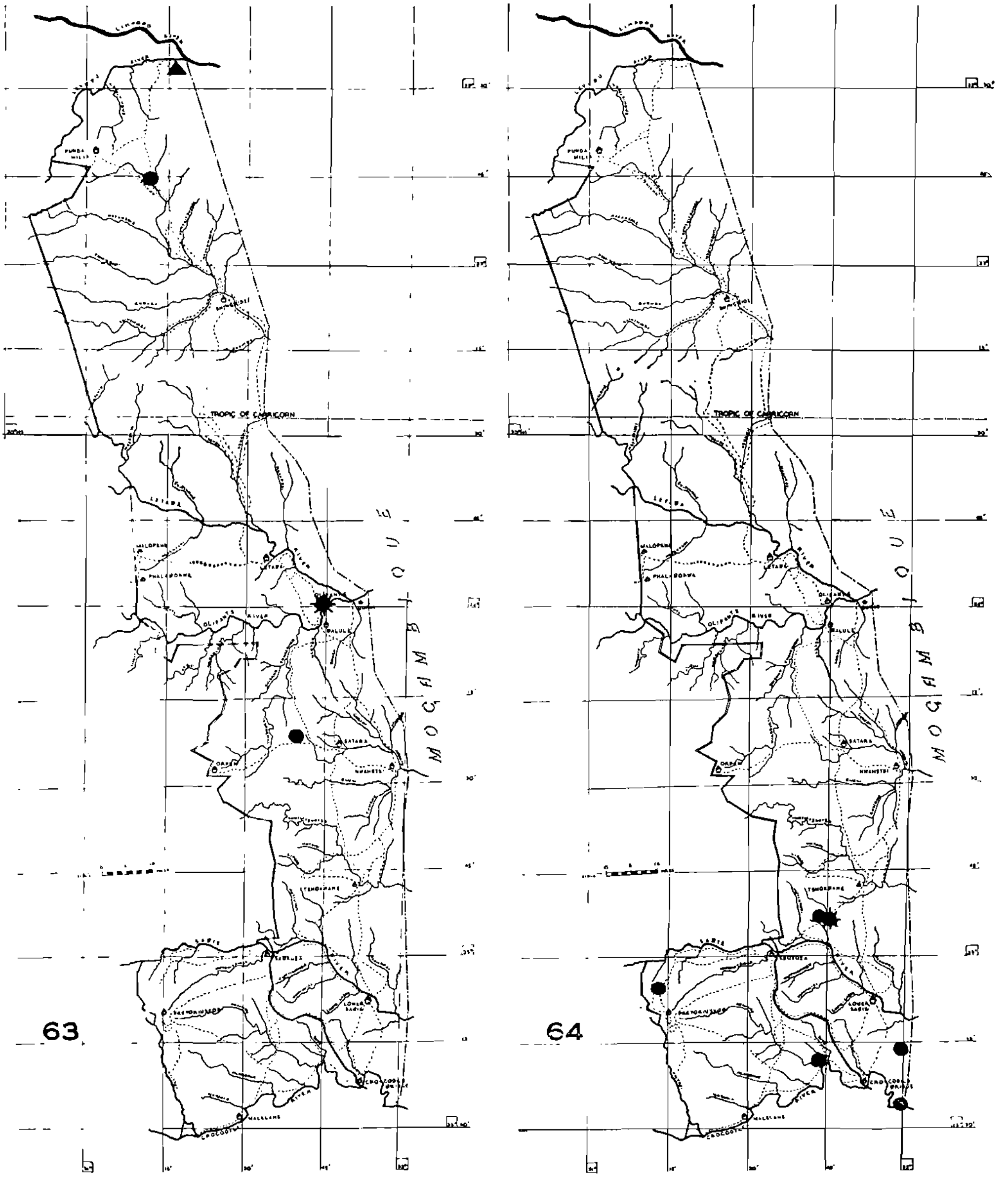
This species, new to the K.N.P., is widely distributed in the Transvaal; it is therefore rather surprising that so far only one specimen has come to light among a number of *Gulella distincta* (M. & P.) from block C 148.

Gulella distincta (Melvill & Ponsonby, 1893), fig. 64

Ennea distincta Melvill & Ponsonby, *Ann. Mag. nat. Hist.* (6) **11,** p. 22, pl. 3, fig. 10, 1893 (type locality: Middelburg, Transvaal).
Gulella distincta; Connolly, *Trans. R. Soc. S. Afr.* **12,** p. 121, 1925; Connolly, *Ann. S. Afr. Mus.* **33,** p. 65, 1939.

K.N.P.: Numbi Koppie, S 22
Godleni, S 74
Crocodile R. bank between Mbyamiti and Bume mouths, S 83
Beacon A, Lebombo Range, S 107
Koppie S. of koppie with Orpen plaque, C 148

Gulella distincta is new to the K.N.P. and appears to occur in a rather limited area in the southeastern Transvaal and Swaziland (*new record*, NM).



Figs. 63-64. Distribution in the Kruger National Park of 63. *Streptostele meridionalis* nov. spec. (dots), *S. sanctuarii* nov. spec. (star) and *S.* spec. indet. (triangle); 64. *Gulella crassilabris* (Crvn.) (star) and *G. distincta* (M. & P.) (dots).

Gulella infans (Craven, 1880), figs. 65-66

Ennea infans Craven, *Proc. zool. Soc. Lond.* 1880, p. 616, pl. 57, fig. 6, 1880 (type locality: Transvaal, Lydenburg).

Gulella infans; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 117, 1925; Connolly, *Ann. S. Afr. Mus.* **33**, p. 26, pl. 1, fig. 6, 1939.

K.N.P.: Numbi Koppie, S 22
Skukuza Koppies, S 28
Manung Koppie, S 35
Pretoriuskop Rest Camp, S 35
Shabin Koppie, S 35
Ship Mountain, S 51
Gorge and surroundings, C 2

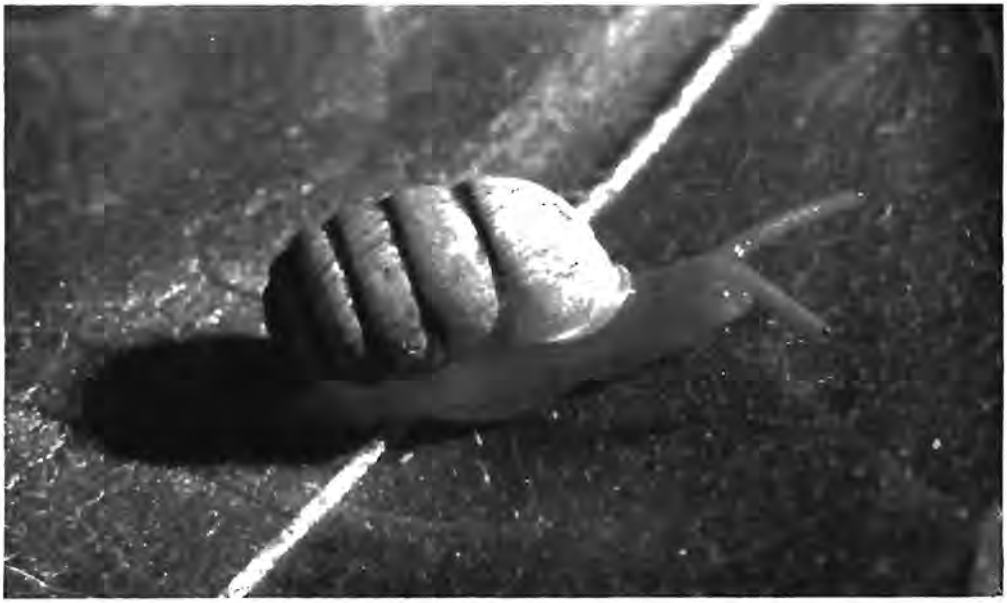


Fig. 65. *Gulella infans* (Crvn.), specimen from between Semane Koppie and Ngirivane windmill, 28.II.1964. Highly enlarged. Photograph Laura Kelsall.

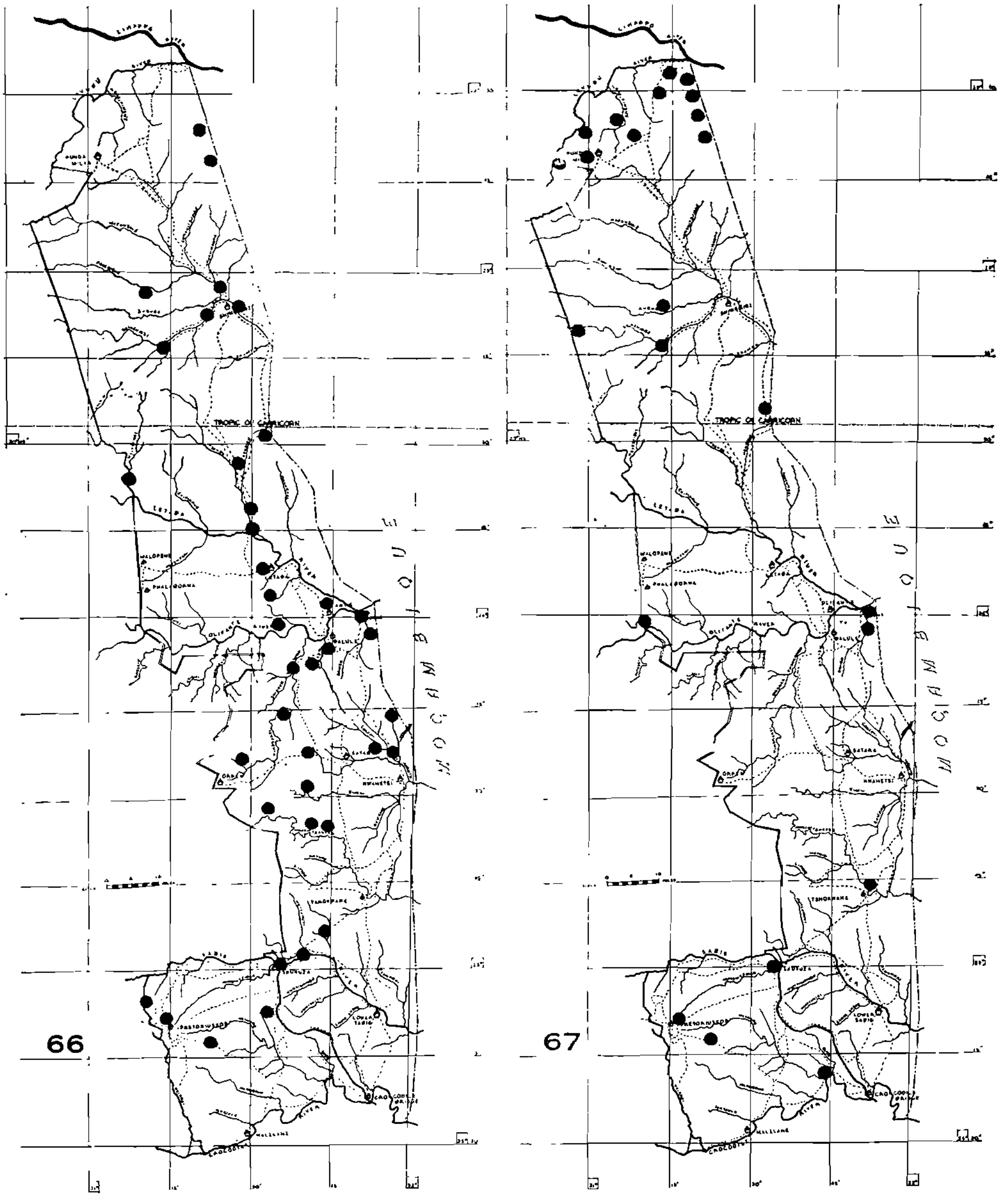
Bangu, C 12
Along main road just S. of Olifants R., C 24
Past junction Timbavati and Shisakashangondzo R., C 30
W. of Ngotsa Dam, C 31
Mbangari Koppie, C 47
Pumbe, C 52
Between Semane Koppie and Ngirivane Windmill, C 69
Shibotwane, C 72
Near Gudzane Dam, C 73

Timbavati Drift, C 77
Just past Timbavati Drift, C 77
Sweni firebreak, C 91
Talamati, C 100
Nwaswitsontso Dam, C 111
Nwaswitsontso R. bank W. of Kumane Dam, C 112
Koppie S. of koppie with Orpen plaque, C 148
Sand R. area, C 155
Sabi-Sand R. loop, C 162
Mahlakuza Pan area, 'Msimbit' forest, N 28
Near Malonga Spring, N 28
Near Nwambiya Pan, Nyandu sandveld, N 46
Near Phugwane R., N 103
Along Shingwedzi R., W. of camp, N 107
N. of Shingwedzi R., N 119
S. of Shingwedzi R., N 119
Shingwedzi R. near rocky waterhole, N 127
Tsange Koppie, N 136
Shilowa Koppie, N 180
Mooiplaas plots, N 187
Shipandane Drift, Tsende R., N 187
Macetse Koppie, N 191
Tsende plots, N 216
Koppie N. of Letaba R. causeway, N 225
W. of Letaba Camp, N 246
Near Mbulweni Pan, N 257
Along Shinobyeni Spruit, N 260
N. of Olifants Camp before 2nd Mangwanduna junction, N 260
Mbulweni sandstone reef, N 269

Gulella infans is a characteristic and widely spread species throughout the K.N.P. The abundant material shows that the species is very variable, particularly as far as shape and size are concerned. On the whole the dentition is rather constant, which accounts for it being easily identified.

Gulella infans is new to the K.N.P. *G. johannesburgensis* (M. & P.) is closely allied to *G. infans*, but has so far not yet been found in the game reserve. *G. infans* is known to occur from Middelburg and the Albany District in the Cape Province to Southern Rhodesia, occurring as far inland as Johannesburg. It is a species typical of the Lowveld, adapted to dry and fairly dry conditions; usually it is found on almost every koppie that is sufficiently well covered with bush and stones. So far it has not been recorded from the Punda Milia sandveld, but this may be a mere coincidence.

Specimens from block C 148 were collected in humus in cracks of large rocks on a koppie together with specimens of *G. crassilabris* and *G. distincta* and those from block N 107 under logs and in humus at the foot of large trees in open gallery forest.



Figs. 66-67. Distribution in the Kruger National Park of 66. *Gulella infans* (Crvn.) and 67. *G. perissodonta* (Stur.).

Gulella perissodonta (Sturany, 1898), fig. 67

Ennea perissodonta Sturany, *Denkschr. Kais. Akad. Wiss. Math.-Naturw. Cl.* **67**, p. 562 (26), pl.1, fig. 18, 1898 (type locality: Mozambique, Lourenço Marques).

Gulella perissodonta; Connolly, *Trans. R. Soc. S. Afr.* **12**, p. 116, 1925; Connolly, *Ann. S. Afr. Mus.* **33**, p. 71, pl. 1, fig. 16, 1939.

K.N.P.: Skukuza Rest Camp, S 7
Shabin Koppie, S 35
Ship Mountain, S 51
Crocodile R. bank between Mbyamiti and Bume mouths, S 83
Gorge and surroundings, C 2
Bangu, C 12
Nwamuriwa Hill, C 136
Near Orpen Dam, C 136
Hape Koppie, N 5
Shaluka, N 5
Pafuri, near border, N 5
Pafuri picnic spot, ex leafmould, N 5
Eastern boundary, high 'Msimbit' forest S. of W.N.L.A. quarters, N 6
Eastern boundary, patch of 'Msimbit' forest, N 6
Near Thambyi Spruit, Pafuri main road, N 11
Eastern boundary, grey soil, N 13
Shalungwa Spring, N 16
Saselandonga Poort, N 20
Road to Shidzivane Lookout, N 22
Near Klopperfontein Dam, N 25
Mahlakuza Pan area, 'Msimbit' forest, N 28
Near Malonga Spring, N 28
Dimbu, W. of Punda Milia, N 30
Shipudze Ridge, N 38
Ponda Hills, N 115
Shangoni Koppies, N 122
Tsange Koppie, N 136
Shibyatsangela Ridge, N 171
Mahulule Koppies, N 273

According to Connolly's monograph (1939) this species was only once found at Lourenço Marques in the second half of the 19th century; he gives a figure of the unique type in the Vienna Museum. Unfortunately this type appears to be lost (Dr. O. Paget, *in litt.*). However, available descriptions and figures leave no doubt about the identity of the species, which, surprisingly enough, is very common in the K.N.P. Accordingly, it is new to South Africa, the Transvaal and the K.N.P. It appears to be much more widely distributed than surmised by both the early authors and Connolly, because the present author has also obtained it in various localities in Swaziland and Zululand (*new records,* NM).

Abundant material from all over the K.N.P. shows that this species is rather variable in size, shape and dentition, particularly in size. The parietal tooth is sometimes so small as to be hardly noticeable, furthermore the cusps on the labral tooth are frequently almost fused so that one usually gets the impression of one undivided slab on the labrum. One abnormal specimen from Mahulule Koppies has a double angular lamella; the additional lamella is situated between the normal angular lamella (and parallel to it) and the minute parietal denticle.

4. NOTES ON SLUGS

Slugs belonging to four different pulmonate families have been collected throughout the K.N.P. One of the species, *Deroceras laeve* of the family Limacidae (see p. 344), is not indigenous, but introduced from Europe; the other species belong to the families Veronicellidae, Urocyclidae and Aperidae. Dr. L. Forcart of the Naturhistorisches Museum, Basle (Switzerland), has kindly undertaken to revise the Natal Museum's extensive Southern African slug material of the above three families and his results will be published in due course. Together with many other specimens the K.N.P. material will be discussed in Dr. Forcart's comprehensive paper, but he has been good enough to send us some preliminary identifications.

The Veronicellidae are represented by two species, viz., *Laevicaulis alte* (Férussac, 1821) and *L. natalensis natalensis* (Krauss, 1848). *L. alte* has been collected in two places in the northern areas of the K.N.P., while *L. n. natalensis* is widely distributed throughout the game reserve, having been collected at about fifteen localities in all three major areas. It has been recorded from localities with high and with low rainfall, and even penetrates the Mopani belt, where few molluscs are able to live. Species of *Laevicaulis* are well adapted to live in Africa's arid areas, needing very little moisture and being protected by the thick and tough skin of the mantle which covers the body completely.

The family Urocyclidae comprises a number of species which have lost their external shell and have become adapted to a life in sheltering types of vegetation, in Southern Africa mainly subtropical and sometimes also temperate forests. *Elisolimax flavescens* (Keferstein, 1866) (formerly known as *Urocyclus flavescens*) is the only urocyclid slug, which so far has been found in the K.N.P.; it has only been collected a few times south of the Sabi River and appears not to be able to live in areas with less than 25 inches mean annual rainfall. Urocyclid slugs are definitely cryptozoic in habits and except in forests are rarely seen actively moving about. During rainy weather the species has been found in grass and on wet rocks.

The carnivorous Aperidae, South Africa's only endemic pulmonate family, are very rare in the K.N.P. However, the two available samples (from blocks C 3 and C 162 respectively) represent a new species each. These are major discoveries indeed, because so far aperid slugs had been found only as far north as Barberton, Transvaal (Forcart, 1963), the main centre of distribution being in Natal and the Eastern Cape Province.

Full data on the K.N.P. slugs of the above three families will be given at a later date.

5. ECOLOGICAL NOTES

The study of the ecology of Africa's land molluscs is still in its infancy. The most important contribution to this field was that of Pilsbry & Bequaert (1927, pp. 461-479). A recent summary of the knowledge of the physiological aspects of ecology in non-marine molluscs has been compiled by Hunter (1964, land molluscs pp. 103-115), while other valuable papers have been published by Boycott (1934) and Mörzer Bruijns, Van Regteren Altena & Butot (1959).

Although the mollusc survey of the K.N.P. has been largely of a taxonomic nature, some notes on the various niches occupied by certain species and on more general aspects of molluscan life do not seem out of place. Because some species were not found alive in the K.N.P., the author has freely drawn upon his general field experience in various parts of Southern Africa, so that as many data as possible have been incorporated.

"In general, land snails are not as perfectly adapted to a terrestrial environment as are insects and amniote vertebrates, and thus more limited in distribution. Many snails are cryptozoic in ecology, and many show nocturnal activity; terrestrial habitats with extreme ranges of temperature or very low humidity do not support snails". (Hunter, *loc. cit.*, p. 104). The K.N.P. environment with its poor rainfall, low humidity and high summer temperatures is certainly not an optimum environment for land snails. This explains the small number of species and the comparative rarity of individuals. The poverty of the land snail fauna of the K.N.P. is also partly due to the subsoil. This mainly consists of granite and Karroo System (basalt, limburgite, and rhyolite of the Lebombo Mountains), which are all poor in lime, being essentially acid soils. Lime in the soil is of great importance in the life of land molluscs, particularly in supplying indirectly the material for constructing the shell, but is not as essential as originally surmised. A few species are calcifuges, but many are able to subsist in environments which are poor in lime, while others seem more or less indifferent to soil conditions.

Most of the species recorded from the game reserve are definitely cryptozoic in habits; the few species which are not, are usually found in forest and allied types of vegetation. Few land molluscs are exclusively adapted to certain micro-environments, so that a considerable overlap in ecological niches can be expected. The following niches may be distinguished:

(*a*) Subterranean niches. Only *Cecilioides* is known to live below the surface of the ground; this genus is represented by *C. gokweanus*.

(*b*) Under logs in top soil: slugs of the family Aperidae.

(*c*) Leaf litter (some species also occur outside this niche): *Gastrocopta damarica*, *G. thomasseti*, *Trachycystis rivularis densestriata*, *Afropunctum zanguebaricum*, *Guppya rumrutiensis*, *Gudeëlla pinguis*, *Nata vernicosa*, *Streptostele* species, *Gulella crassilabris* and *G. distincta*. Most of these species are small to very small. In drought periods this habitat becomes more crowded and under those circumstances almost any species may be found in this environment, which, particularly in sheltered areas, retains moisture for a considerable time. Leaf litter from the Pafuri picnic site (fig. 68) has yielded some particularly interesting specimens.

(*d*) In (long) grass: *Pupilla fontana*, *Rachis jejuna*, *Succinea* species and urocyclid slugs (the latter only during and after rain or dew has fallen).

(*e*) On the trunks of trees, usually on or under the bark: *Conulinus* species and *Rachistia sticta*. Other species in diapause will shelter under the bark of trees.

(*f*) On leaves of shrubs and herbs, usually in the shelter of thick bush or forest: *Sheldonia poeppigi*, *Gudeëlla pinguis* (also in leaf litter), urocyclid slugs and *Nata vernicosa*.

(*g*) Generally sheltered environments, such as under stones, rocks, logs, at the foot of trees and shrubs, even low on the trunks of trees sheltered by surrounding grass and herbs, and under dry leaves: *Tropidophora ligata*, veronicellid slugs, *Pupoides calaharicus*, *Succinea* species, *Trochonanina* species, Subulinidae (except *Xerocerastus burchelli*), *Achatina immaculata*, *Gonaxis gwandaensis*, *Streptostele* species, *Gulella infans* and *G. perissodonta*.

Fig. 68. Pafuri picnic spot on the banks of the Levubu River. Leaf litter from this locality has yielded some very interesting minute species.

(*h*) More open ground, usually with sand, pebbles, rocks and a sparse vegetation: *Pupoides calaharicus* (also under rocks) and *Xerocerastus burchelli*.

(*i*) Anthropochorous species: *Deroceras laeve*, in Europe partial to grassland, cultivated areas and the neighbourhood of water.

Few if any species are restricted to the types of vegetation as described in the introduction. Many species seem to avoid the Mopani belt, as evidenced by the distribution maps; this probably represents a tendency to avoid a low rainfall area rather than a particular type of vegetation. Rainfall seems to play an important rôle indeed; the case of the genus *Xerocerastus* has recently been worked out (Van Bruggen, 1964b). Furthermore it seems that the distribution of *Conulinus mcbeanianus* (figs. 12, 15), *Subulina mamillata* (fig. 35) and *Pseudoglessula boivini* (figs. 40-41) is also closely connected with rainfall and the resultant types of vegetation.

The most suitable habitats for land snails in the K.N.P. are the more luxurious types of riverine forest and well-weathered koppies with abundant vegetation in higher rainfall areas. Examples are the Sabi-Sand Rivers island (fig. 69) and the koppies around Pretoriuskop Rest Camp. Outside these sheltering types of environment land snails are only active at night (when it is sufficiently moist) and/or during or after rain or dew has fallen.[7] The dry winter season (April-October) is characterised by little if any activity; even unseasonal rains usually do not bring the snails out of their hiding places (see, e.g., sub *Rachis jejuna*). Almost all land molluscs are in diapause during this period, most of them on or slightly in the ground under logs, rocks, stones, leaves, etc. or under the bark of trees (Enidae, Succineidae, occasional slugs). Summer droughts, which can be very bad indeed, are also passed in diapause. Many species are able to secrete an epiphragm (rarely even two close to each other: *Xerocerastus*) to protect the aperture (Subulinidae, Achatinidae) while others cling to the surface of rocks, trees and dead leaves by secreting quickly hardening mucus (Enidae, Succineidae, etc.).

Most land molluscs are herbivores, mainly subsisting on lichens, algae and fungi, and also to a lesser degree on higher plants; carnivorous families are represented in the K.N.P. by the Aperidae, Rhytididae and Streptaxidae with a total of eleven species, or only about 22% of the total number of species. Southern Africa as a whole has about 25% carnivorous species on a total of 631 species of land molluscs (data computed from Connolly, 1939). Comparative figures for tropical Africa are even higher. Carnivorous land snails tend to occur where there is an abundant supply of food (soft-bodied invertebrates, such as worms, molluscs, etc.), which accounts for most records originating from areas with a high rainfall and consequently more luxurious vegetation than the K.N.P. can offer. This may also explain the low percentage of predacious snails found there.

Epiphragms and certain types of mucus have definite survival value (see above); the same may possible hold true for whitish shells in open, hot and dry environments (*Xerocerastus* species and outside the K.N.P. many desert-dwelling Acavidae, e.g., *Dorcasia*), while the intensity of the pattern on the shell of *Tropidophora ligata* may also have something to do with this (see systematic list sub *T. ligata*). The thick skin of the mantle of slugs of the family Veronicellidae makes these snails particularly well adapted to the dry environments so typical of many parts of Africa.

The rôle of land molluscs in the general ecology of the K.N.P. is only modest on account of their relative rarity. The terrestrial snails generally contribute to the usual activities of the soil fauna, such as the conversion of the leaf litter, aerating top layers of the soil, etc., but attention may also be drawn to the rôle played by the large *Achatina immaculata*. Throughout the game reserve this snail is fairly plentiful and it must consume immense quantities of higher plants, this being one of the rather few species, which include in their diet a variety of higher plants. Apart from supplying food to a host of various small vertebrate predators (small mammals, birds, etc.), the empty shell is used as a shelter by invertebrates and small vertebrates such as for instance the ant-mimicking spider *Myr-*

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[7] Occasionally droughts can be so intense that dew disappears completely.

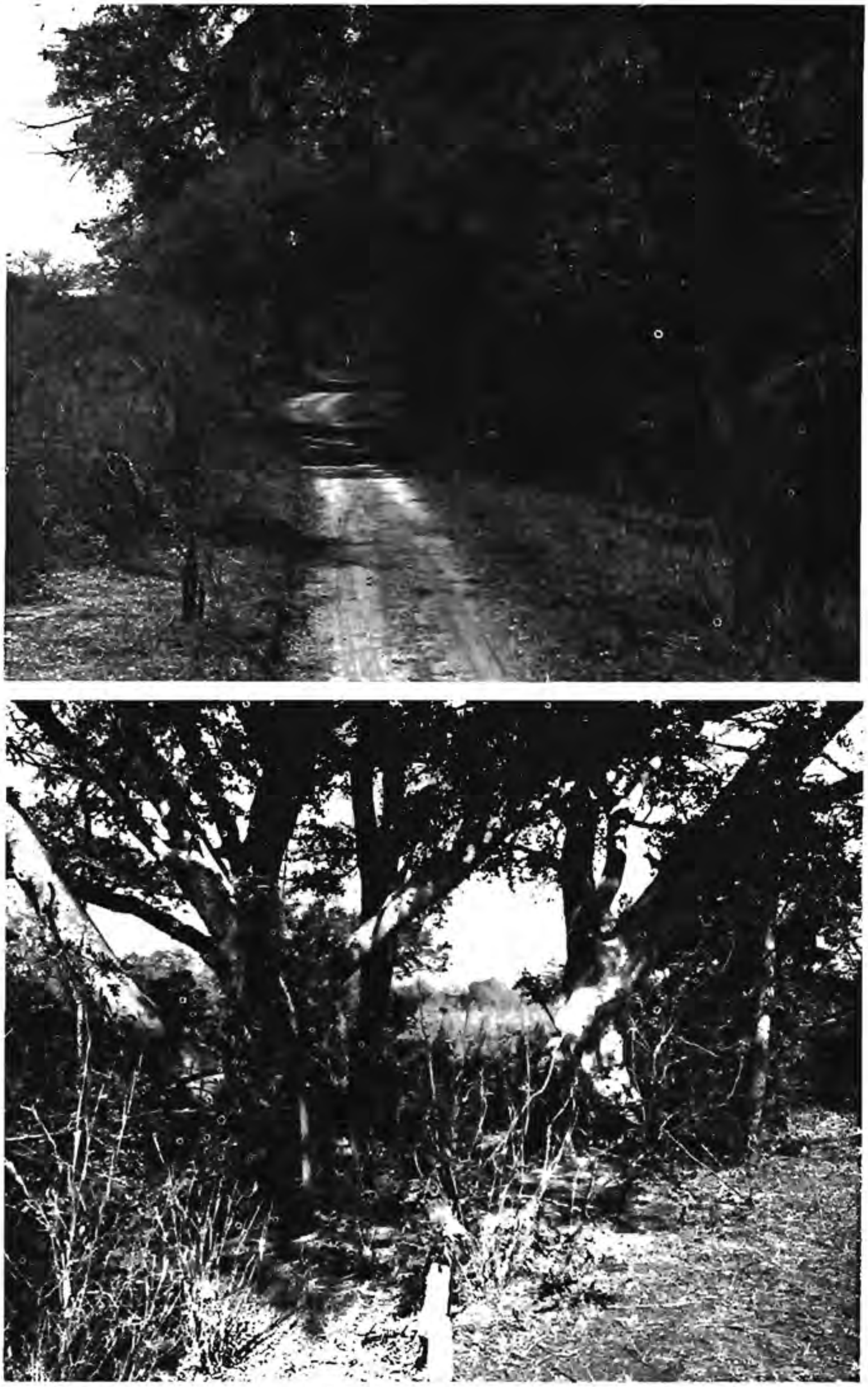

Fig. 69. Two views of the vegetation in the area between Sabi and Sand Rivers, blocks C 154, 155, 162. Photographs National Parks Board.

marachne (recorded once only[8]) and the nocturnal gecko *Pachydactylus p. punctatus* (Peters)[9]. When rainwater fills the empty shells, they may be used by mosquitoes as breeding vessels.

Small vertebrate predators take their toll of land molluscs. Some years ago a case of a giant mongoose (*Ichneumia albicauda* (Cuv.)) having fed on seven slugs of the genus *Laevicaulis* came to my notice (see Dixon, 1964, p. 47). On the Sabi-Sand Rivers island many broken shells of *Trochonanina mozambicensis* were found near clumps of weathered rocks housing colonies of the dwarf mongoose (*Helogale parvula* (Sund.)), at least suggesting a heavy predation on this mollusc. Jackal, hyena and civet are known to take *Achatina immaculata*[9]. Apart from species of the family Viverridae, insectivores and rodents are known to eat land molluscs as well. Frogs, toads and certain lizards also take molluscs (see e.g., Pilsbry & Bequaert, *loc. cit.*, p. 473), while snakes of the genus *Duberria* are specialised snail-feeders. Among birds two species of guinea-fowl, various francolins and a number of other species (mainly Non-Passeres) have been recorded as having shown terrestrial molluscs in their crops and stomach contents (Chapin in Pilsbry & Bequaert, *loc. cit.*, pp. 475-479). Ground hornbills (*Bucorvus leadbeateri* (Vigors)) are reported to consume many *Achatina immaculata*.[9]

6. ZOOGEOGRAPHICAL NOTES

Far from being typically South African, the fauna of the K.N.P. is rather of tropical origin. Poynton (1964, map 3) shows that as far as the amphibians are concerned the area mainly derives its fauna from tropical sources with a few transitional and temperate or Cape elements disturbing the pattern; the more detailed data of Pienaar (1963b) show that of 31 species of frogs and toads 26 (= 84 %) are of tropical origin, while only 3 (= 10 %) and 2 (= 6 %) represent transitional and temperate elements respectively. It appears that for land molluscs the pattern is rather different because of the larger transitional element, which is understandable because of different ecological tolerance. Indeed, molluscs may be able to live in areas where amphibians can not.

Of a total of 50 species, 30 or 60 % may be considered tropical (*sensu* Poynton, *op. cit.*), viz.,

Tropidophora ligata
T. transvaalensis
T. spec.
Laevicaulis alte
L. n. natalensis
Pupilla fontana
Pupoides calaharicus
Rachis jejuna
Conulinus metuloides
C. sordidulus
Trochonanina mozambicensis
Gudeëlla pinguis
Elisolimax flavescens
Cecilioides gokweanus
Subulina gracillima
S. mamillata
Pseudoglessula boivini
P. hamiltoni
Achatina immaculata
Archachatina subcylindrica

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[8] Recently 3 of a sample of 74 shells of *Achatina craveni* Smith (NM) from the Sibasa Dist. (Transvaal) appeared to shelter one specimen of *Myrmarachne* each.

[9] Note added by Dr. U. de V. Pienaar.

C. transvaalensis
Rhachistia sticta
Succinea africana
Afropunctum zanguebaricum
Guppya rumrutiensis
Gonaxis gwandaensis
Streptostele meridionalis
S. sanctuarii
S. spec.
Gulella perissodonta

seventeen or 34% may be considered transitional, viz.,

Gastrocopta damarica
G. thomasseti
Conulinus mcbeanianus
Succinea arboricola
S. exarata
S. striata
Trachycystis rivularis densestriata
Trochonanina thermarum
Sheldonia poeppigi
Opeas lineare
Xerocerastus burchelli
Euonyma varia
Achatina bisculpta
Nata vernicosa
Gulella crassilabris
G. distincta
G. infans

while only two or 4% may be considered temperate or Cape elements, viz., the two new *Apera* species. The single remaining species (2%), *Deroceras laeve*, is anthropochorous and thus does not come into the zoogeographical picture at all.

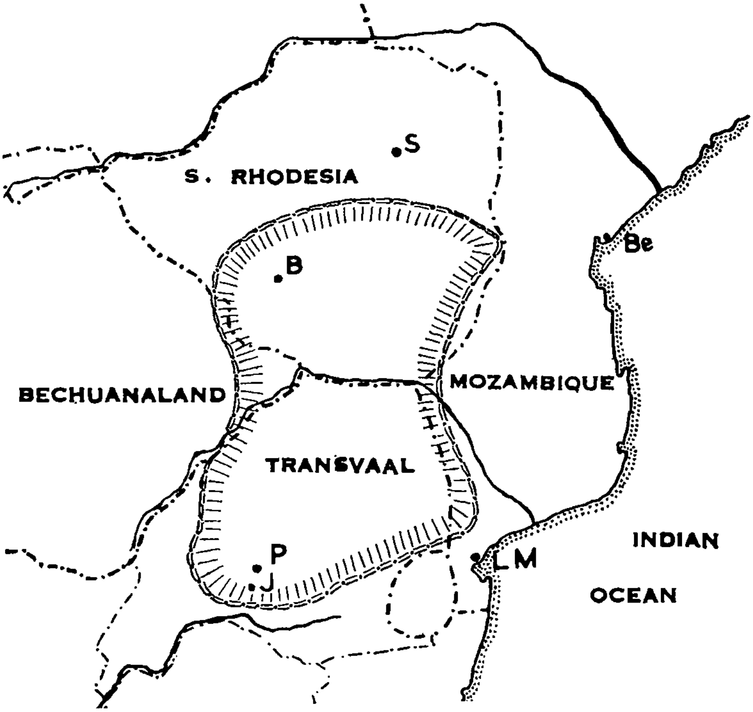

Fig. 70. Endem-centre in the Transvaal and S. Rhodesia. B = Bulawayo, Be = Beira, J = Johannesburg, LM = Lourenço Marques, P = Pretoria, S = Salisbury.

Succinea africana is probably a border-line case; the few available records (Victoria Falls, Limpopo R., K.N.P.) are unfortunately not very helpful, but the fact that it occurs at the Victoria Falls accounts for it being included in the list of tropical species.

It is interesting to draw attention to the number of transitional species centering around the Transvaal and sometimes also the Rhodesian plateau. These are *Conulinus mcbeanianus* (fig. 15), *Trachycystis rivularis densestriata*, *Trochonanina thermarum*, *Opeas lineare*, *Euonyma varia*, *Achatina bisculpta*, *Gulella distincta* and *G. crassilabris*. Among amphibians this phenomenon is obviously rare (probably only *Breviceps sylvestris*, which is a forest dweller, cf. Poynton, *op. cit.*, map 19), but it seems quite common among land molluscs. The pattern is usually that of a fringe of localities in the Lowveld, Southern Rhodesia and eastern Bechuanaland, with a number spilling over on to the Highveld (fig. 70). The area is fairly dry, in parts even arid, and one might be inclined to suppose that it was invaded from the moister fringes and that subsequently a good deal of speciation took place in numerous probably empty niches, once the adaptation to an arid climate was achieved. This is also borne out by the fact that e.g., the eight above-mentioned species are almost all closely allied to species which are considered tropical in their distribution.

The above data are by no means the last word in distribution interpretation of Southern African land molluscs, because very many are based only on the scantiest of records. However, at least it shows that the malacofauna of the K.N.P. as a whole is allied to that of the East African Plains with a fair number of transitional species mainly derived from the Transvaal and Rhodesian plateau.

The heterogeneous nature of the composition of the list of terrestrial molluscs of the K.N.P. is clearly demonstrated by the fact that one species and one genus reach their northern limits here (*Gastrocopta thomasseti* and *Apera* with two species), three species their eastern limits (*Conulinus mcbeanianus* and *Euonyma varia*, both of the Transvaal Highveld, and *Xerocerastus burchelli* of the central desert region), four species and one genus their southern limits (*Conulinus metuloides*, *Afropunctum zanguebaricum*, *Subulina gracillima*, *S. mamillata* and the genus *Streptostele* with three species) and two species their western limits (*Rhachistia sticta* and *Pseudoglessula boivini* of the Mozambique Plains). On the whole one may consider the K.N.P. malacofauna to represent an impoverished offshoot of that of the Mozambique Plains, probably mainly on account of the low rainfall.

Of the 50 species discussed here five are new (*Pseudoglessula hamiltoni*, *Streptostele meridionalis*, *S. sanctuarii*, and two species of *Apera*), seven are new to the South African list (*Conulinus metuloides*, *Afropunctum zanguebaricum*, *Guppya rumrutiensis*, *Subulina gracillima*, *S. mamillata*, *Gonaxis gwandaensis* and *Gulella perissodonta*), while fourteen are new to the Transvaal and forty to the K.N.P. as compared to the data of Haas (1936) and Connolly (1939).

It is hoped that this survey has laid the foundations for further research of a taxonomic nature concentrating on (*a*) species of which the anatomy is as yet unknown, (*b*) rare, small, minute, and slug species, and (*c*) poorly known areas of the game reserve. Ecological investigations also seem eminently desirable, particularly in view of the preservation of certain parts of this great National Park as integral reserves not to be disturbed by human activities.

7. REFERENCES

Adam, W., 1951. A propos d'un "reclassement" du genre Thapsia Albers, 1861. *J. Conchyl.* **100:** 72-81.

——1954. Études sur les mollusques de l'Afrique centrale et des régions voisines I. Vertiginidae et Valloniidae. *Vol. Jub. Victor van Straelen Bruxelles* **2:** 725-817.

Bequaert, J. C., 1950. Studies in the Achatininae, a group of African land snails. *Bull. Mus. comp. Zool. Harvard* **105:** 1-216.

——and Clench, W. J., 1936. Studies of African land and fresh-water molluscs. Notes on Gonaxis Taylor, with description of a new species. *J. Conch.* **20:** 263-270.

Blume, W., 1952. Achatina subcylindrica deisenbecki n. subsp. *Arch. Molluskenk.* **81:** 61-62.

Boycott, A. E., 1934. The habitats of land Mollusca in Britain. *J. Ecol.* **22:** 1-38.

Braga, J., 1952. Materiais para o estudo da fauna malacológica de Moçambique. *An. Junta Invest. Ultram. Est. Zool.* **7:** 65-127.

Bruggen, A. C. van, 1963a. On a sinistral specimen of Afristreptaxis elongatus (Mollusca, Gastropoda, Pulmonata) from South Africa. *Rev. Zool. Bot. afr.* **67:** 17-19.

——1963b. Report on the Mollusca of the 1961 Harvard-Smithsonian-Transvaal Museum Kalahari Expedition. *Ann. Transv. Mus.* **24:** 261-270.

——1964a. On some molluscs from Mount Gorongosa, Portuguese East Africa, with descriptions of two new streptaxids. *Rev. Zool. Bot. afr.* **70:** 113-122.

——1964b. On the distribution of the genus Xerocerastus Kobelt & von Möllendorff, 1902 (Mollusca, Gastropoda Pulmonata, Subulinidae). *Zool. Mededel. Leiden* **39:** 224-234.

——1964c. The distribution of introduced mollusc species in Southern Africa. *Beaufortia* **11:** 161-169.

——1965. Two new species of Achatinidae (Mollusca, Gastropoda Pulmonata) from the Drakensberg Range with general remarks on Southern African Achatinidae. *Rev. Zool. Bot. afr.* **71:** 79-91.

Brynard, A. M., 1964. The influence of veld burning on the vegetation and game of the Kruger National Park. Ecological Studies in Southern Africa, ed. by D. H. S. Davis, *Dr. W. Junk Publishers, The Hague:* 371-393.

Codd, L. E. W., 1951. The trees and shrubs of the Kruger National Park. *S. Afr. Bot. Surv. Mem.* **26:** 1-192.

Connolly, M., 1912. A revised reference list of South African non-marine Mollusca; with descriptions of new species in the South African Museum. *Ann. S. Afr. Mus.* **11:** 59-306.

——1922. Notes on African non-marine Mollusca with descriptions of many new species. *Ann. Mag. nat. Hist.* (9) **10:** 485-517.

——1925. The non-marine Mollusca of Portuguese East Africa. *Trans. R. Soc. S. Afr.* **12:** 105-220.

——1939. A monographic survey of South African non-marine Mollusca. *Ann. S. Afr. Mus.* **33:** 1-660.

Dixon, J. E. W., 1964. Preliminary notes on the mammal fauna of the Mkuzi Game Reserve. *Lammergeyer* **3:** 40-58.

Forcart, L., 1963. Slugs of South Africa. *Proc. mal. Soc. Lond.* **35:** 103-110.

Franca, M. L. P., 1960. Sobre uma collecçao malacológica recolhida na Ilha da Inhaca (Moçambique). *Mem. Junta Invest. Ultram.* (2) **15:** 41-102.

Germain, L., 1935. Contributions à l'étude de la faune du Mozambique. Voyage de M. P. Lesne (1928-1929). 17e Note—Mollusques terrestres et fluviatiles de la Province de Mozambique (Afrique Orientale Portugaise). *Mem. Estud. Mus. Zool. Univ. Coimbra* (1) **80:** 1-72.

Haas, F., 1934. Beschreibung einiger afrikanischer Binnenschnecken. *Zool. Anz.* **107:** 221-224.

——1936. Binnen-Mollusken aus Inner-Afrika, hauptsächlich gesammelt von Dr. F. Haas während der Schomburgk-Expedition in den Jahren 1931/32. *Abh. senckenb. naturf. Ges.* **431:** 1-156.

Hunter, W. R., 1964. Physiological aspects of ecology in non-marine molluscs. Physiology of Mollusca, **1** ed. by K. M. Wilbur & C. M. Yonge, *Academic Press, New York-London:* 83-126.

Jickeli, C. F., 1874. Fauna der Land- und Süsswasser-Mollusken Nord-Ost-Afrika's. *Nov. Act. Kais. Leop.-Carol. D. Akad. Naturf.* **37:** 1-352.

Lawrence, R. F., 1964. The Solifugae, scorpions and Pedipalpi of the Kruger National Park. *Koedoe* **7:** 30-39.

Mandahl-Barth, G., 1958. Intermediate hosts of Schistosoma. African Biomphalaria and Bulinus. *Wrld Health Org. Monogr. Ser.* **37:** 1-132 (reprinted from *Bull. Wrld Health Org.* **16:** 1103-1163, 1957, and *ibidem* **17:** 1-65, 1957).

Martens, E. von, 1897. Beschalte Weichthiere Deutsch-Ost-Afrikas. *Deutsch-Ost-Afr.* **4:** 1-308.

Mead, A. R., 1950. Comparative genital anatomy of some African Achatinidae (Pulmonata). *Bull. Mus. comp. Zool. Harvard* **105:** 219-291.

Mermod, G., 1951. Les types de la collection Lamarck au Muséum de Geneve. Mollusques vivants. II. *Rev. Suisse Zool.* **58:** 693-752.

Mörzer Bruijns, M. F., Regteren Altena, C. O. van, and Butot, L. J. M., 1959. The Netherlands as an environment for land Mollusca. *Basteria* **23** *Suppl.:* 132-162.

OWEN, D. F., 1965. A population study of an equatorial land snail, Limicolaria martensiana (Achatinidae). *Proc. zool. Soc. Lond.* **144**: 361-382.

PIENAAR, U. DE V., 1963a. The large mammals of the Kruger National Park—their distribution and present-day status. *Koedoe* **6**: 1-37.

————1963b. The zoogeography and systematic list of Amphibia in the Kruger National Park. *Koedoe* **6**: 76-82.

PILSBRY, H. A., 1904-1905. African Achatinidae. *Man. Conch.* (2) **17**: i-xviii, 1-232.

————1919. A review of the land mollusks of the Belgian Congo chiefly based on the collection of the American Museum Congo Expedition, 1909-1915. *Bull. Am. Mus. nat. Hist.* **40**: i-x, 1-370.

————1920-1921. Pupillidae. *Man. Conch.* (2) **26**: I-IV, 1-254.

————1946. Land Mollusca of North America (North of Mexico) 2, 1. *Monogr. Acad. nat. Sci. Philad.* **3**: I-VI, 1-520.

————& BEQUAERT, J., 1927. The aquatic mollusks of the Belgian Congo with a geographical and ecological account of Congo malacology. *Bull. Am. Mus. nat. Hist.* **53**: 69-602.

POYNTON, J. C., 1964. The Amphibia of Southern Africa: a faunal study. *Ann. Natal Mus.* **17**: 1-334.

PRESTON, H. B., 1912. Additions to the land molluscan fauna of Rhodesia. *Ann. Mag. nat. Hist.* (8) **9**: 69-72.

QUICK, H. E., 1936. The anatomy of some African Succineae, and of Succinea hungarica Hazay and S. australis Férussac for comparison. *Ann. Natal Mus.* **8**: 19-45.

REES, W. J., 1950. The giant African snail. *Proc. zool. Soc. Lond.* **120**: 577-598.

SCHIJFF, H. P. VAN DER, 1957. Ekologiese studie van die flora van die Nasionale Krugerwildtuin (unpublished thesis University of Pretoria).

SPARKS, B. W. & GROVE, A. T., 1961. Some Quaternary fossil non-marine Mollusca from the Central Sahara. *J. Linn. Soc. Lond. Zool.* **44**: 355-364.

STURANY, R., 1898. Catalog der bisher bekannt gewordenen Süd-afrikanischen Land- und Süsswasser-Mollusken mit besonderer Berücksichtigung des von Dr. Penther gesammelten Materiales. *Denkschr. Math.-Naturw. Cl. Kais. Akad. Wiss. Wien* **67**: 537-642 (also separately pp. 1-106).

VERDCOURT, B., 1958. Notes on Kenya land and freshwater snails. 5. Records of Vertiginidae and Valloniidae from Kenya, Zanzibar and Tanganyika. *Basteria* **22**: 1-9.

————1959. Notes on Kenya land and freshwater snails 6. The genus Afropunctum Haas in Kenya and Uganda. *Basteria* **23**: 91.

————1960. Observations on the generic relationships of several East African Helicarionidae. *J. Conchyl.* **100**: 107-117.

————1961a. A new species of Helicarionidae from Portuguese East Africa together with a discussion of the affinities of several other East African species. *J. Conchyl.* **101**: 120-134.

————1961b. Notes on the snails of North-East Tanganyika. *Corynd. Mus. occ. Pap.* **8**: 1-23.

————1963. Further notes on Afropunctum Haas. *J. Conch.* **25**: 158-160.

WALDÉN, H. W., 1963. Historical and taxonomical aspects of the land Gastropoda in the North Atlantic region. North Atlantic Biota and their history, *Pergamon Press, Oxford-London-New York-Paris:* 153-171.

WENZ, W., 1938-1944. Gastropoda Prosobranchia. Handb. Paläozool., *Gebrüder Borntraeger, Berlin-Nikolassee* **6**, 1: 1-1639 (fotomechanischer Nachdruck).

ZILCH, A., 1939. Landschnecken aus Deutsch-Südwest-Afrika. *Arch. Molluskenk.* **71**: 216-253.

————1959-1960. Gastropoda Euthyneura. Handb. Paläozool., *Gebrüder Borntraeger, Berlin-Nikolassee* **6**, 2: I-XII, 1-835.

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